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THE MYCETOZOA, AND SOME QUESTIONS WHICH THEY SUGGEST.—I.

By the Right Hon. Sir EDWARD FRY, D.C.L., LL.D., F.R.S., and AGNES FRY.

WE are desirous to make known some small friends of ours to those who are hitherto unacquainted with them; but we are embarrassed as to how to introduce them—by what name to present them. It is true that they bear several names derived from the Greek language, Mycetozoa, Myxomycetes, Myxogastres, Myxothallophyta, but these are not familiar words. In German these organisms bear a name which has been translated into English, but it is so repulsive that we would willingly suppress it if we could, just as one would not like to introduce a charming girl to strangers by some name of a distinctly disagreeable suggestion:—

> "A name? if the party had a voice,
> What mortal would be a Bugg by choice?
> As a Hogg, a Grubb, or a Chubb rejoice?"

And so what beautiful little thing would, if it had a voice, be introduced as a "slime fungus"? and yet this is the only English name of the organisms in question. Some intimates of these ill-named beings try to get over the difficulty by inventing pet names, and call them "myxos," or "myxies," and, on the whole, we incline to adopt the latter word. It is short, and it rhymes with pixies.

But what are these myxies? someone will be impatient to say. Are they fungi? No. Are they mosses? No. Are they ferns? No. Are they lichens? No. At any rate, plants? That is doubtful. Then surely they are animals? We do not know. They are living things—and beyond that we will not go for the present.

There is another difficulty in the way of presenting these organisms to the novice: that their forms and structure are so far unlike those of plants or animals with which every one is familiar that we cannot use very well-known terms in describing them, and we shall have to ask permission to employ some special terms, when common ones fail. But we shall endeavour to be as clear as we can, and to readers who will give us their attention we believe that we shall overcome these obstacles, and we believe, too, that a little difficulty in following the exposition will be more than repaid by the interest of the subject. It appears to us that many most interesting biological problems are presented in very simple form by this class of organisms, and we shall not hesitate to refer to these from time to time in the following pages.

If our reader will turn over the pages and look at the illustrations which follow, he will by his eye get a general notion of the kind of thing about which we are going to talk.

LIFE-HISTORY.—We propose in the first place to sketch the life-history of one of these organisms as an example of all, and then to retrace our steps and dwell a little more in detail on points of interest which emerge in the consideration of the several stages of its existence.

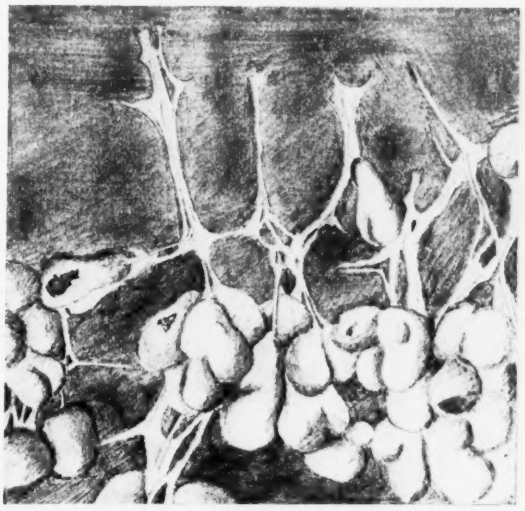


FIG. 1.—*Badhamia utricularis*, showing Sporangia.

If our reader will look at Fig 1., he will see depicted an organism consisting of a number of bodies somewhat like grapes in shape; he will see that each little berry is attached by a tender stalk to a substance which is a piece of dead wood, and he will notice that these berries are so grouped together as to suggest the notion of a common origin. This little organism is known as *Badhamia utricularis*, the generic name being derived from a Dr. Badham,

a labourer in the field of cryptogamic botany, and the specific name describing the bladder-like form of the principal part of the structure. This species is not uncommon, and is to be found on stumps and logs of decaying wood.

The bladder-shaped vessels which we have spoken of are the spore cases of the organism, *i.e.*, they are cases in which the spores are stored, much as seeds are stored in a seed vessel. They are known as *sporangia*. We have chosen to begin with the organism in this form because it is the most conspicuous, and therefore the most easy for a beginner to get hold of.

If now a specimen of this Badhamia be placed under the microscope, it will be seen that the coat of the sporangium is a delicate shell containing minute granules of lime, and that the dark appearance of the body is due to the brown spores which lie beneath the transparent shell. Next if a sporangium be broken and the contents examined under the microscope (as shown in Fig. 2), it will be found that the delicate white shell contains a network of threads, also white from the lime with which they are charged, and that they occupy the interior of the sporangium, and pass from wall to wall much like the cancelli in a long bone. In addition to these threads there are the small round spores. In these threads we have come upon a very characteristic structure in these little organisms; it is found in the sporangia of most of them but in very varying forms, and very diversely arranged, of which we shall say more hereafter. This system of hairs in the sporangia is known as the *capillitium*.

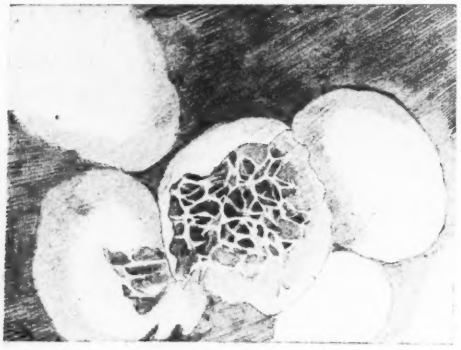


FIG. 2.—*Badhamia utricularis*, broken Sporangia showing Capillitium.

As the sporangia contain spores it will be at once understood that we stand on the threshold of a new generation, and we must now follow the history of the spores. These, when carefully looked at, are seen to be covered with minute spines, and thus present a somewhat rough appearance.

If now the spores be placed under favourable circumstances, *i.e.*, with sufficient moisture and warmth, small translucent bits of naked protoplasm will be seen to emerge from them, leaving a mere shell behind them; these bits of protoplasm have a movement of their own in the water, and can be seen both to shake themselves, and to move forwards; they push out a part of their protoplasm as a whip or *flagellum* at one end of the body, swimming with this in front of them, the whip having a sort of lashing movement. Fig. 3 exhibits some of these bits of protoplasm. Their motions are particularly amusing to watch; they swim, they wriggle, they revolve, they shake themselves, they are full of life and motion; they seem at once wilful and purposeless; they gambol with one another, and their frolics remind one of young lambs in spring. They are capable not only of motion but of digestion, and of the capture of food in a manner to be hereafter described. These little pieces of protoplasm bear several names, and as the variety of phraseology is apt to puzzle students, we pause to say

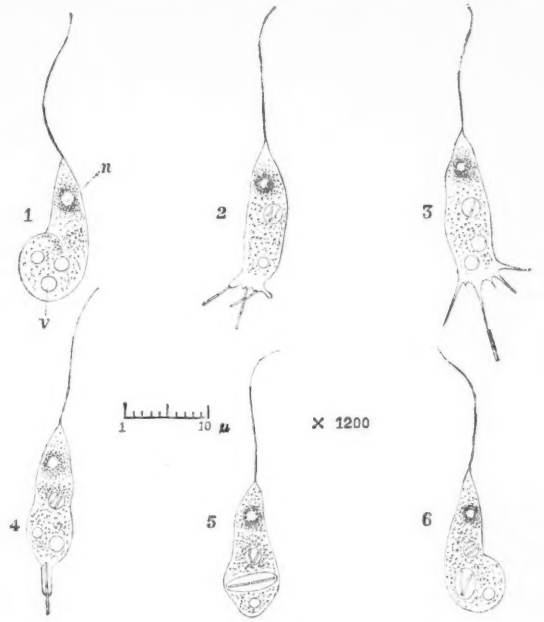


FIG. 3.

1.—Swarm Spore of *Stemonitis fusca* of the usual form when swimming. *n*. Nucleus; *v*. Vacuoles.

2.—Swarm Spore with three Bacilli adhering to expanded posterior extremity.

3.—A Swarm Spore with delicate pseudopodia, to one of which a Bacillus is attached.

4.—The same Swarm Spore. The Bacillus in the act of being drawn in and partly invested with a tube-like extension of the body surface.

5.—The same Bacillus contained in a long vacuole, and bulging out the sides of the Swarm Spore.

6.—The same Bacillus bent double after violent jerking movement of the Swarm Spore.

(From *Journ. Linn. Society, Botany*, Vol. 25, p. 440, by permission of the Linnean Society and Mr. Lister.)

that they are called sometimes swarm spores, or swarm cells, sometimes zoospores, and as individual pieces of protoplasm they are sometimes called protoplasts. The spore of a moss, or of a fern, is a small structure, endowed with no power of motion; these swarm spores, as we have seen, have a power of motion; the spore of the moss, or the fern, is capable by itself of reproducing the plant from which it has come, but these swarm spores are only reproductive after fusion with others, as we shall hereafter see. The name swarm cell is likely to mislead, because the thing so called is protoplasm without any containing wall, and therefore does not answer to the notion of a cell as it exists in a beehive or in a police station. We shall therefore speak of them as *swarm spores*, though even that name seems to us to be far from felicitous.

The next step in the life of these swarm spores is that they rapidly increase by bi-partition, *i.e.*, splitting into two parts. An occasional phenomenon here sometimes intervenes. At times the swarm spores assume a globular form,

and become covered with a hard coating, and in that condition are known as *Microcysts*. But from the wall of this cyst the contents afterwards escape, and renew their movements.

The swarm spores (whether after encystment or not) now enter upon a new stage. They gather together and fuse into masses of naked protoplasm, the swarm spores losing their individuality in a common mass. This mass is called a *plasmodium*. This plasmodium grows in bulk by the digestion of food, such as bits of fungus or dead wood, and attracts to, and unites with itself, other smaller plasmodia of the same species. In the *Badhamia utricularis* this plasmodium is yellow; it is white in many species; green or orange, or red or grey in other kinds. This plasmodium moves, sometimes through the substances of dead wood, in other cases on the surface, expanding in an irregular fan shape, and marked irregularly by streaks or veins, as may be seen in Fig. 4. It appears to move in

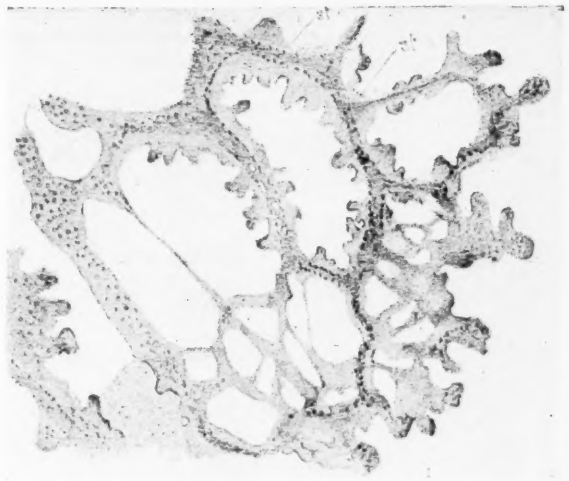


FIG. 4.—Streaming plasmodium of *Didymium leucopus*. (After Cienkowski.)

search of its requisite food. The Badhamia is much devoted to fungi, and will extend itself over the surface of a fungus till it has devoured all its more delicate parts.

In the substance of this plasmodium there arises a strong alternate movement of the more fluid protoplasm, a rush of circulation through the channels of the plasmodium. The granules move for a short time in the one direction, then pause, and then move in the opposite way. The strongest currents are indicated in Fig. 4 by the letters *st*.

The plasmodia of different species differ much as regards size. In some genera they are very visible, and were known to some of the older botanists as Mesenteriæ, and were believed to be a species of fungus. In some cases they can only be discovered by the microscope; and, haunting the interstices of dead wood, they are rarely visible. Such are the plasmodia of Lycogala, Arcyria, and of some species of Trichia.

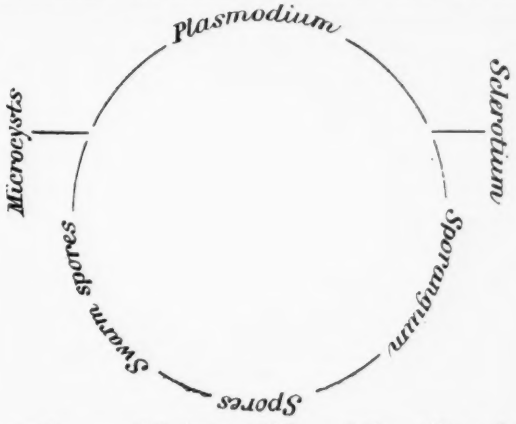
Here, again, a phenomenon of encystment sometimes occurs. During drought the plasmodium may become quite dry and hard without losing vitality. In this stage the hard plasmodium bears the name of *sclerotium*. That of the Badhamia is quite horny, and orange-red in colour. On being wetted it will resume its old plasmodium form, and move as before.

This conversion from an active into a passive condition of the plasmodium seems to be brought about by two conditions—the want of moisture and the want of food. This last fact is illustrated by a case in which a plasmodium placed on wet cotton wool, but without food, was found to turn into a sclerotium. The capacity for rest and awakening is thus a protective one, and enables the organism to tide over a time of famine or drought. It is certainly a better plan even than the Lydian practice of playing games to forget hunger.

From the plasmodium stage, whether broken into by a sclerotium condition or not, the organism, after a time, prepares for its next effort. It seeks some spot, on the surface of dead wood or leaves, sometimes a rather exposed and elevated position, at other times a sheltered one, and there forms sporangia, so that what before was a mass of more or less amorphous protoplasm has differentiated itself into several parts, into delicate pedicels, the coating membrane of the sporangia, the hairs of the capillitium, and the spores—which in due time are to begin again the circuit of the life-history of the Badhamia, which is in all essential features that of the whole group of myxies. The sporangia in the course of their development sometimes undergo a great change in colour; for instance, the young sporangia of Comatricha are an ivory white, and they gradually change into a glossy black; and the groups of little tree-like growths with their developing forms and varying colours, all gathered together within a few square inches, is a sight of great beauty. In the maturity of this sporangium stage of the organism it has lost all its powers of locomotion, it has lost its powers for digestion, and in its stationary condition devotes its energies to the reproduction of the species. The motion of the granules of the protoplasm continues to some extent until the formation of the spores.

Now, pausing here for a moment, and taking merely the outline of the facts as we have drawn it, we have surely abundance of matter for thought and surprise. Some seventy years ago, Fries, one of the first naturalists who grasped the series of changes through which these organisms pass, compared these changes to the metamorphoses of insects. We get, too, an inkling of the difficulty which naturalists have felt in assigning the myxies either to the animal or the vegetable kingdom: their locomotion and rapacious youth seem to shut them out from the plants; their stationary condition and their production of sporangia from the animal world.

The life-history of our organism may be briefly summarized in the following diagram, in which the circle



shows the essential stages of life, and the outliers show occasional and non-essential stages.

We wish to dwell a little more on some of the points of

interest which arise from the brief narrative we have given, and from other facts which may be brought in relation to it, and in doing so, we shall find it best to consider the life-history of the organism in a different order from that previously used. We started with the sporangium, as the most easily grasped and the best known stage of life; but we shall now ask you to consider the life-history by passing from the simpler to the more complex stages.

SWARM SPORES.—And first let us revert to the swarm spores, those little bits of mere translucent protoplasm which escape from the spores of the myxie (Fig. 3), leaving the shells of the spores, from which they have emerged, behind, as in like manner the spores leave behind them the membrane of the sporangium. We have seen that in some cases the myxies form a membrane or coat—as in the sporangium, the spores, the microcysts, and the sclerotium; and it is probable that this membrane is in some, though comparatively few, cases of the same or a similar nature to the material of cell walls in the higher plants, *i.e.*, is formed of cellulose. But what is to be noted is this, that these membranes are used only as protections; they are allowed no part or lot in the vital actions of the organism, and, so soon as their protection is no longer wanted, they are cast off and allowed to perish. It is evident that the contained protoplast and not the containing membrane is the dominant partner in the concern.

A swarm spore has been defined as "a mobile, ciliated, asexual, reproductive cell, destitute of all membrane," or, in other words, it is a piece of protoplasm without any covering membrane, which is produced without any sexual action, and which of itself possesses the powers of motion, of putting out cilia or hairs, and of joining in the reproduction of the species to which it belongs. That all this should be true of a little bit of jelly is marvellous enough, and presents some of the mysteries of life in a very simple and condensed form.

Swarm spores, in the sense of the preceding definition, are common in both the great kingdoms of organized life. There is a whole group of protoplasts which, under the name of Monads, are reckoned to belong to the animal kingdom; there is the group of somewhat larger organisms known as "Amœbœ"—a group of which a suspicion has sometimes been entertained that they are an immature form of other organisms; there are the white particles of the blood which are almost, if not quite undistinguishable from Amœbœ; there are the swarm spores, whether belonging to the Algæ, the Fungi, or the Myxomycetes; in all these cases the protoplasts are of the same kind, endowed with nuclei and vacuoles, capable of putting out cilia, and endowed with the power of motion and assimilation. To all appearances there is no essential difference between them, and yet, in point of fact, they are organisms as distinct as possible from one another in their nature and their future careers.

One thing marks off the swarm spores of the myxies from all other swarm spores which reproduce the organism; they are reproductive only in conjunction. The swarm spore of an alga is capable by itself of reproducing an alga; in the myxies, on the other hand, the swarm spores only reproduce when they have merged with their fellows and formed a plasmodium. This phenomenon of the union of a large number of individual swarm spores into a new and larger individual which carries forward the course of life is unique in the myxies, and distinguishes them broadly from all other known organisms.

In all cases in which reproduction depends on swarm spores it seems essential that there should be water enough for the swarm spores to live and move about in; and, in the case of myxies, to enable them also by their movements to join together into a plasmodium. Nothing is known of their reproduction except in water.

It would at first sight appear that this condition of their reproductive activity cannot be otherwise than inconvenient and restrictive, especially in the case of such myxies as, *e.g.*, the Comatrichæ, which often produce their sporangia on the upper sides of wood, or on the tops or sides of wooden posts. But it is probable that a very little moisture is enough, and that in a shower of rain, or in a morning's dew, they find sufficient water for the swarm spores to live and unite. But we confess that the point seems to us to require further attention.

Water being the medium in which most of the lowest organisms exist, it is generally thought that the doctrine of evolution involves this—that the earth has been peopled by migrations from the water: and the migrations of amphibious animals from the one element to the other have been dwelt on as assisting us to understand such migration. In this connection the cases of the myxies and of the mosses, and no doubt of other mainly terrestrial organisms which need water as a necessary condition to fertilization, are worthy of note. One of the most important functions of life still depends on the presence of the original medium of their lives.

CELL THEORY.—The swarm spore is, as we have said, a bit of naked protoplasm; so is the plasmodium. Let us consider briefly what is meant by the expression naked protoplasm.

When in the seventeenth century the microscope was applied to vegetable tissues, especially by our countrymen Hooke and Grew, and by the Italian Malphigi, they were struck with the presence of small walled cavities in the fleshy parts of plants. These Hooke called cells, and Grew and Malphigi utricles or bladders. Hooke's name has stuck to them, and plays a great part in botanical writings from his day to the present. We are accustomed to regard the cell division as the determining factor in growth, the mode of division providing, as it were, the form which the plant is to assume: and especially since the days of Schleiden and Schwann—when the cell came to be regarded as the structural unit in the growth of plants—the tracing of cell development, and the structure of the parts of the cell (especially the cell walls), and the behaviour of the cell, have been studied with the utmost care. Presently it came to be seen that the cell walls were inert and by no means the most important part of the structure, but that the slimy contents of the little box, which had been treated with scant attention in the earlier stages of study, were, after all, the most remarkable part of the cell, and were to all appearance the basis of both animal and vegetable life. When attention was first called definitely to it in the vegetable kingdom it was termed protoplasm, by Mohl; when first accurately observed in animals it was named sarcode by Dujardin; and by-and-by it was found that protoplasm and sarcode were one and the same thing. Then instances were found in which small masses of protoplasm lived and moved without any cell walls at all, but so firmly was the notion of the cell rooted in the minds of many physiologists, that these naked pieces of protoplasm have often been called naked cells, a most confusing term as it seems to us, for it is like calling a man with nothing on "a naked great coat." Another name, and a much more convenient one, is protoplast.

The accepted cell theory received something like a shock when the life-history of the myxies came to be carefully studied. "All the phenomena," said Cienkowski, in the year 1863, "which are observed in plasmodia are calculated to force the observer from the accustomed path of safety

to those of doubt. The fundamental conception of morphological investigation of the cell leaves us wholly in the lurch in the case of plasmodia. Neither cell membrane, nor nucleus, nor other histological elements can be established in this case by the most benevolent interpretation of the facts, and, twist the cell theory as we may, it certainly cannot be fitted to the naked flowing protoplasm of the Myxomycetes." Nuclei, however, have since been found in plasmodia.

The cell walls of ordinary plants are composed of a peculiar substance known as cellulose, and within these the protoplasm of the cell is contained, with all that may be contained in the protoplasm—the nuclei, the chlorophyll, the colouring, and the oily matter, &c. The cell is thus a highly organized unit, and it is, moreover, capable of carrying on most marvellous operations, physical and chemical.

An organism which commences life in the simple form of a piece of protoplasm, in many cases produces cell walls and rests in these, and thus builds a home for itself in which it lives and labours. But in the case of the Myxomycetes this does not occur, or occurs only very exceptionally, and all the actions which these organisms perform, and all the beautiful forms which they assume, are reached without ever forming a cell wall or constituting a true cell, except in the spore itself. In these actions and in these forms we see the capacities of simple and naked protoplasm. The extreme simplicity of the mechanism seems to bring to the mind more powerfully the inherent powers of the worker.

(*To be continued.*)

OZONE AND ITS USES.

AMONG the many interesting bodies which the researches of modern chemists have brought to light, few are more remarkable than the substance to which Schönbein gave the name "Ozone" in the year 1840. Little studied, this useful form of matter had been recognised for fifty years before receiving its name, which, as every reader with an elementary knowledge of Greek will know, is meant to accentuate one of its chief properties, its peculiarly strong smell. Ozone was originally thought to be an oxide of hydrogen, having a composition represented by the symbol H_2O_3, but when several chemists independently succeeded in obtaining it by passing electric sparks through perfectly dry oxygen this was seen to be impossible. Further researches conclusively demonstrated that ozone was nothing more than a condensed form of oxygen.

Though ozone has never yet been obtained in a pure state, chemists have a very satisfactory knowledge of its properties. Its smell resembles that of weak chlorine. When compressed, ozone has a blue colour, and is eventually converted into an indigo-coloured liquid, which, according to Troost, boils at $-119°$. It is a strong oxidiser; that is to say, it readily decomposes into ordinary oxygen, at the same time combining with suitable substances which may be present. It has been used in this way to bleach engravings discoloured by age, but the method is not altogether satisfactory. The possible applications of the strong oxidising powers of ozone are very numerous, since, while being so energetic an oxidiser, its action is also very simple. Unlike other substances used by chemists to give up their oxygen, ozone leaves no residue behind. It has consequently been suggested that ozone should be used to bleach beeswax, starch or bones; in the manufacture of varnishes, and also to accelerate the maturing of wines and spirits. Though considerably more experience than is at present available will be necessary before these applications of ozone can be successfully accomplished, there seems no reason why, after the effects of successive additions of the gas, and the adjustment of the proper amounts necessary in each particular case, have been studied, ozone should not become a very important commercial product.

It must, however, be at once pointed out that these have only recently become practicable possibilities. Until the advent of the process which we shall presently describe, ozone had been prepared on a small scale only, either by the action of the silent electric discharge on air or oxygen, by the electrolysis of dilute sulphuric acid, or by the slow action of clean phosphorus on moist air; but by none of these methods can it be obtained in any quantity. Of these three plans for obtaining ozone that of the electric discharge is the one most commonly employed in the laboratory, and the form of apparatus in most general use is known as "Siemens' induction tube." This consists of a sort of Leyden-jar, formed of a smooth metal tube which fits into a wider tube coated with tinfoil on its outer surface, leaving a narrow annular space between them. Between the two tubes a stream of dry oxygen gas is passed, which, when the inner and outer coatings are connected with the terminal wires of an induction-coil, becomes electrified by induction, and from ten to fifteen per cent. of the oxygen is thus transformed into ozone.

But though pieces of apparatus like that of Siemens prove satisfactory enough in preparing small quantities of ozone suitable for chemical research, they are quite inadequate for the generation of quantities large enough to be used commercially. Mr. Andreoli has recently patented a process which, though fundamentally similar to the laboratory plan of Siemens, is yet able to produce ozone at a marketable price. The construction of this patent is based upon the familiar tendency of an electric discharge to flow off a point, and in the apparatus designed by Mr. Andreoli, serrated grids of aluminium, each carrying seventeen thousand seven hundred and sixty points, are used. These grids form electrodes, and each one is placed opposite a sheet of aluminium with a plate of glass between. The three things, the grid, the glass, and the aluminium plate, are bound together by suitable wooden clamps. Though the construction of the apparatus would naturally lead one to suppose that occasional large sparks would occur from the metallic points, and so cause the union of some of the oxygen and nitrogen in the air which is acted upon, Mr. Andreoli states that no such compound of nitrogen and oxygen is formed. If this really is so, the production of ozone is uninterfered with, but this point requires to be more thoroughly investigated by chemists before a definite statement can be made with reference to it.

The applications of ozone seem likely to rapidly increase in number. It has become very popular among sanitary specialists as a means of purifying contaminated air. It is employed medicinally for the cure of persons suffering from fœtor of the breath, the inhalation of ozone causing a complete disappearance of the unpleasant symptoms. In the treatment of ulcers and wounds of all kinds it has proved invaluable, for under the influence of ozone such diseased parts readily become healthy, rapidly exhibiting an active tendency to heal. It is becoming common to ensure the sanitation of hospital wards by diluted ozone. The organic germs are destroyed by the oxidising power of the ozone, and consequently the bacteria of typhoid, cholera, dysentery, small-pox, fevers, etc., are killed.

In all those industries where oxidation plays an important point, ozone is becoming more and more used. Thus it has been employed for sterilizing foul casks and vats; for the rapid oxidation of drying oils; for seasoning

XUM

wood; in vinegar making, and in bleaching textiles and tissues. These facts afford justification for believing that ozone will soon be one of the most familiar instances of the application of scientific knowledge to everyday processes.

TWO MONTHS ON THE GUADALQUIVER.

By Harry F. Witherby.

I.—THE RIVER.

To the ornithologist, the Guadalquiver, at all events from Seville to its mouth near Cadiz, is one of the most interesting rivers in Europe. In times gone by most of the country on each side of the river for about twenty miles from its present mouth was covered by the sea. But the land has been reclaimed, not by the Spaniards, but by the river itself. For countless years the river deposited at its mouth, layer upon layer, the innumerable particles which its waters brought down to the sea, and thus, gradually, the sea-bottom was raised, until at length the sea was ousted and level plains appeared. Then the sea began to fight for the land, but it fought against itself, for it threw up sandbanks round the margin of this newly formed land. The wind blew the sand, and the sandbanks increased in length and breadth until they completely shut out the ocean. Thus, the river, the sea, and the wind combined to form a great flat expanse of many square miles in extent. The plains so formed are known in Spain as the *marismas*. A small part of them is wooded with pine and cork-oak, or covered with a dense undergrowth of tamarisk, gorse, cistus, and other shrubs, but by far the greater portion consists of mud and marsh, flooded by the river in winter and burnt up by the sun in summer. The human population of these plains consists only of a few herdsmen—wild picturesque-looking men, armed with long sticks and wearing rough sheepskin coats and long apron-like leather gaiters. These men live during the summer in rude huts built of reeds, and they, with the help of their dogs, watch over great droves of horses, bulls and sheep.

Fig. 1.—Stalking in the *Marismas*.

An ornithologist visiting this country recognises at once that it is an ideal place for many kinds of birds. Food and nesting sites are plentiful and varied, and the country is very little disturbed. Moreover, this corner of Europe lies in the track of a vast number of birds of many kinds, migrating from Africa to the north of Europe in spring, and from the north to their winter quarters in Africa in the autumn. Many of these migrants are induced, by prospects of food and seclusion, to break their journey for a few days in this congenial wilderness.

Towards the end of March, 1898, my friend, G. Chenevix Trench, and myself left England to follow in the footsteps of such noted ornithologists as the late Lord Lilford,

Fig. 2.—The Stalker from the Bird's Point of View.

Messrs. Abel Chapman, H. E. Dresser, and Howard Saunders, who have all explored this wonderful country. Our principal object was to collect *Limicolæ*, or wading birds, for a special purpose. We also hoped to get many other birds, and we knew that we should see many sights in the way of bird-life which possibly might have been seen many years ago in England but will never be seen again, owing to the great marshes of the East Coast having been drained and cultivated.

Once arrived in Spain, delays innumerable and unlooked for occurred, and we soon learnt to know the meaning of that much abused word *mañana*, which signifies any day but to-morrow. It was not therefore until April 4th that, with all preparations made, we boarded our boat at the little village of C. and sailed off down the river. The boat, or "sheep," as the owner called it, which was our home for six or seven weeks, was a half-decked barge-like lugger, by no means extravagantly fitted, but roomy and well suited for our purpose. The Guadalquiver is noted, amongst other things, for its thick and muddy water, its strong tides, and for the wind which is nearly always blowing on it. Never once did we see more than three or four inches below its surface, never once was the tide favourable, and as to the wind it was either not blowing at all, or, when it was blowing, it was, owing to the winding nature of the river, of little use. As a consequence, instead of four hours we took ten to arrive at our first camping place. But when one is in Spain one must do as the Spaniard does. If one cannot be moving, then, surely, it is much more pleasant to sit still and smoke the delicious *cigarillo*. What true Spaniard ever loses an opportunity of employing himself in this way? But there were many things to attract our attention on this slow voyage, and consequently it was not always possible to adopt the Spaniard's methods. We were passing through the wonderful *marismas* for the first time in our lives, and although there was very little of the country to be seen from the river our field glasses were constantly in use. Parts of the river bank were thickly grown with reeds from which proceeded the hoarse

and incessant song of the great reed warbler.* We were very anxious to see the birds, but they clung to their reeds and we did not catch sight of one until some time afterwards under more favourable circumstances. There were many ducks on the river, and waders on its banks, to be carefully looked at, while now and again we passed a reed-hut or a stack, the top of which was occupied by a stork† sitting upon her nest. Once, on turning a sharp corner as we were drifting down close to the river bank, we came face to face with a great bustard‡ in all his glory. We were so struck by the suddenness of the meeting, and by the imposing size of the turkey-like bird standing on the bank above us, that we had scarcely time to realise what we saw before the bird had turned and

FIG. 3.—About to turn the Horse.

fled from our sight. I hope to say more of the great bustard, for we both saw and shot them afterwards. We saw many kites soaring in the distance, and once we were treated to a very fine sight in bird-life. Some two hundred or three hundred yards from the river there was evidently a carcase, which we could not trace from the boat, but the kites and vultures, those excellent scavengers, had found it. We counted two hundred black kites§ and four Egyptian vultures‖ in the air, and there must have been many more on the ground. They were evidently gathering from far and near. Many appeared as mere specks floating up aloft, but as one's eye passed down the "column" of birds, it could be seen that each individual with wings outstretched was sweeping round and round in gigantic circles, ever coming nearer and nearer to the earth, while its place above was taken by another speck intent upon the feast. So they succeeded one another, and what was but a dot in the sky grew gradually larger and larger until one could see the real size of the bird, and then its markings and feathers. We saw many such sights during our stay in Spain, but never again on so grand a scale.

It was dark before we had tied up our boat alongside an island in shallow water. Our ever cautious commander remarked that the steamers plying up and down this river were very careless as to whom they ran down, but, said he, if a steamer tries to come where we are she will run aground before she can get near us. So we felt safe as we turned in to our little cabin and dosed off to the accompaniment of many strange cries from birds flying over our boat.

The next day (April 5th) we explored the island to which our boat was anchored. This island was almost entirely covered with reeds, not ordinary reeds such as one sees in England, but reeds as thick as one's wrist, and from twelve to fifteen feet high. Moreover, they grew so thickly together that it was exceedingly hard work to force a way through them. Here and there we came to a comparatively open spot, covered with broken reeds to the depth of two or three feet. In three of these open spaces we found nests in the shape of large heaps of broken reeds, on the top of which were hollows lined with finer stuff. Two of these nests contained round dirty white eggs, which we were able to identify with certainty by shooting two female marsh harriers* as they rose from them. We often caught sight of a purple heron† flying above us, and seeing some rise up a little distance off we forced our way through the reeds to the spot. Our labours were rewarded by the discovery of several nests, built high up amongst the reeds. We soon cut them down, and possessed ourselves of the bluish-green eggs which they contained.

Perhaps our most interesting find on this island was a nest of the black kite. The nest, which contained two eggs, was placed like a heron's, in the reeds. The black kite usually breeds in trees, and sometimes in cliffs and towers. There could be no doubt about this nest in the reeds, for we shot the bird as it flew from it, and the eggs were typical kites' eggs. Our men said it was a common habit of the black kites to build in these tall reeds. Kites were numerous in the neighbourhood, and trees were very scarce, but the reeds seemed to form an efficient substitute.

As we were nearing the boat, after a four hours' "fight"

FIG. 4.—Turning the Horse.

with the reeds, we saw three harriers in the air: a pair of Montagu's‡ (the male slate-grey, and the female dark brown), and a marsh harrier, a much larger bird, with grey wings and tail, and dark body. The smaller birds were stooping at their larger cousin, while he kept tumbling in the air in his endeavours to evade his tormentors. What was the cause of the disagreement I do not know, but the effect formed a very pretty sight.

We visited this extraordinary island again on May 13th, and found a nest of Montagu's harrier, containing five

* *Acrocephalus arundinaceus.* † *Ciconia alba.* ‡ *Otis tarda.*
§ *Milvus migrans.* ‖ *Neophron percnopterus.*

* *Circus æruginosus.* † *Ardea purpurea.*
‡ *Circus cineraceus.*

eggs. Here, again, we were lucky enough to shoot the female bird, and thus identify the eggs without a doubt. This nest was nothing more than a few pieces of old broken reeds placed on the ground, and well hidden in the midst of a patch of young reeds. We also found on this day a beautiful nest of the marbled duck,* containing thirteen rich cream-coloured eggs.

Arrived at the boat, we sailed some way down the river, and eventually anchored at the mouth of a small creek, which was to be our camping place for a week or so while we explored the *marismas*. I shall reserve for my next article the description of what we saw and obtained in this wilderness of water and mud, scantily covered with coarse vegetation. There was little to be seen from our boat. A great expanse—flat and unbroken, save for a few cattle, a reed hut or two, and a distant clump of trees—stretching away to the horizon in front, while the river, with its muddy waters and calm surface, flowed evenly behind us.

There is a very general idea that in a wild and uncultivated country where few human beings are to be found the birds are much tamer than in a populous country such as England. We did not find this to be the case in Andalucia; indeed, many birds which we had always considered tame and confiding in England were quite the reverse in the *marismas*. Those who have collected in other wild countries will bear me out in this, the reason for which I think must be that in a country where man is rarely seen the birds never have a chance of becoming accustomed to him, and consequently shun him in the same way that a horse will shy at a strange object by the roadside. There was no cover above a foot high in this part of the *marismas*, and it may well be asked how we managed to get near enough the birds to shoot them.

The wild-fowler in England uses a punt to approach

FIG. 5.—Tying Head to Tail.

his birds, or he stalks them through some short cover, or he hides himself and waits for the birds to come to him. The *patero*, the wild-fowler of the *marismas* of Andalucia, uses a specially trained horse, from behind which he steals unawares upon the flamingo, goose, or duck. We were accompanied by two *pateros*, each with his stalking horse, or *cabestro*, and I may safely say that we should have collected very few birds in these open plains without the help of our *cabestro*. They were small and poor looking animals, but they never seemed to tire, and were exceedingly well trained to their work.

If the reader will turn to the accompanying illustrations he will get a general idea as to how these horses are used. Suppose you wish to approach a flock of birds feeding far out in a shallow lake. You go as near as you dare, walking upright behind the horse, but you must be careful. The birds take no notice of anything under the horse's belly, but if they catch sight of your head or hat above his back they are alarmed directly. They are already

FIG. 6.—The Shot.

looking suspicious, although you are still a long way off. You stop, and the horse is so well trained that he immediately stops also, and puts his head down as though he were feeding. There is nothing for him to eat except dry caked mud, but the birds do not know that, and seeing him quietly feeding, they take no more notice of him than of the thousands of half-wild horses and bulls which inhabit the *marismas*. Your *patero* arranges the halter, studies the wind and the situation of the birds, and then the stalk begins in earnest.

The *patero* has the halter in one hand and his gun in the other. With his body bent, so that nothing appears above the horse's back, he walks slowly and carefully along, keeping close to its shoulders. He guides his beast by means of the halter and his elbow, the latter being kept pressed into the horse's ribs (Fig. 1). Now and again he takes a look at the birds from under the neck of his *cabestro*. You follow exactly in his footsteps, keeping close to the horse, with one hand on his hip, so that when he takes a long or quick stride you may not be left behind, and thus be seen by the birds. Meanwhile, the horse itself is acting with great intelligence. He goes along slowly, lifting his legs carefully, and putting them down with great deliberation, and all the while his head is kept low, as though he were browsing or drinking. You have been approaching the birds at an angle, and it soon becomes necessary to turn and make another tack. The *patero* stops, and, going a step away from the horse, motions you to step aside too, and crouch behind him. He then gives the halter a sharp pull, and the horse turns round so quickly that the birds scarcely notice the action (Figs. 3 and 4).

On you go again, and are soon trudging through the water. There are many things to try you. The horse stirs up the mud, and you cannot see where you are putting

* *Anas angustirostris.*

your feet. As a consequence you are continually plunging and slipping into some deep hoof-mark in the mud. You suddenly feel a wet stinging slap, and you find your face has formed a barrier between the horse's wet tail and a villainous fly on his flank. The perspiration is streaming off you, and your back is aching unbearably. Just as you are beginning to think that you must give it up to stretch your back at any cost, the *patero* suddenly stops. The relief is great as you squat down, and your surprise is greater when you take the field glasses, and looking under the horse's belly discover that the birds are quite close. Before proceeding further a rope is fastened to the halter, passed between the horse's legs and tied to its tail. (Fig. 5.) This is a necessary precaution to ensure the horse keeping his head down. Were he to raise it when so near the birds they would probably become alarmed. At last you get within shooting distance, the signal is given, the horse stops, and, cocking your gun, you stand up. The relief to your cramped and aching back is so great that for a moment you stay stock still and survey the birds to which the *cabestro* and his master have brought you so cleverly and so successfully. Now the unsuspected danger suddenly dawns upon the flock—there is a straining of necks and a flutter of wings. Raising your gun you fire over the horse's back, or, if there is time, rush out from behind him and fire in the open. The well-trained *cabestro* never moves while you shoot. Drooping his head, he remains like a block of wood until the spoil is collected and you return to him.

These beloved *cabestros* were our constant companions during our stay in the *marismas* and many were the birds we watched, photographed and shot from behind them.

WITT'S PLANET DQ.

ONE of the most important astronomical discoveries of recent years is the finding of the planet DQ, by Witt. This object will come nearer to the Earth than any other similar object, except the Moon. Its minimum distance is about fifteen million miles, and the corresponding parallax nearly a minute of arc. To determine the photometric brightness of this object, the stars, —6°5567, —6°5579, —6°5600, —6°5608, and —6°5626 were each measured on five nights with the meridian photometer, eight settings being made each night, with the resulting magnitudes, 7·87, 8·65, 8·71, 8·56, and 9·57, respectively. The probable error of these values varies from ±0·020 to ±0·033. The brightness of the stars, —6°5550, —6°5560, and —6°5588 was later determined differentially from these, with the resulting magnitudes 8·80, 9·89, and 8·37. Mr. Wendell compared the planet on six nights by means of the photometer with achromatic prisms attached to the fifteen-inch equatorial. The number of settings on each night was forty-eight. On September 5th and 6th, 1898, it was compared with —6°5626, on September 9th with —6°5608, on September 12th with —6°5579, and on September 13th and 14th with —6°5588. The resulting magnitudes were 12·19, 11·97, 12·10, 12·01, 12·20, and 12·29. Mean, 12·13 ±0·04. As the logarithms of the distances of the Sun and Earth, on the mean date, September 10th, were 0·2366 and 9·9115, the magnitude when these distances are both unity becomes 11·39.

It is not easy to obtain photographs adapted to determining the photographic brightness of this object, owing to its faintness and rapid motion. With a short exposure the image is very faint, and with a long exposure a trail is obtained which cannot be compared with the circular images of adjacent stars. Measures of the photographic brightness have been made by Mrs. Fleming on plates taken with the eight-inch Draper telescope, and having exposures of about fifteen minutes. The planet was not far distant from the variable star T Aquarii and was compared with four of its comparison stars whose photometric magnitudes had already been determined. Plates taken on September 6, 12, 13, 13, 13, 13, 14, 17, 20, and 21, 1898, gave the magnitudes 12·78, 12·75, 12·80, 12·85, 12·78, 12·75, 12·75, 12·72, 12·65, and 12·68. Mean, 12·75 ±0·01. Similar measures of two isochromatic plates taken on September 17th and 20th, gave the magnitudes 12·80 and 12·61. Mean, 12·70 ±0·08. Since the planet is fainter photographically than photometrically, it is probable that its colour, like that of the Sun, is redder than an average star.

Several interesting photometric problems present themselves in connection with this object. First, the approximate diameter may be determined by comparison with the brighter asteroids and satellites, assuming that the reflecting power is the same. Secondly, the great variation in the distance of this object from the earth will afford an excellent test of the law that the light varies inversely as the square of the distance. The existence of an absorbing medium in the solar system will thus be tested. Thirdly, owing to the proximity of this object to the Earth at opposition, its phase angle will vary by a large amount. It will, therefore, afford an excellent test of the law connecting this angle with the variation in brightness, which has been found by two or three observers independently.

NEBULA IN ANDROMEDA.

A comparison of photographs of the nebula in Andromeda taken with the eight-inch and eleven-inch Draper telescopes on September 20th and 21st, 1898, with similar photographs taken in 1893, 1894, 1895, and 1896, fails to show the new stellated appearance recently announced by Seraphimoff, of Pulkowa. See also *Astron. Nach.* 147, p. 223.

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CONSIDERATIONS ON THE PLANET SATURN.

By E. M. ANTONIADI.

RECEIVING from the sun less than one-ninetieth of the heat sent us from that luminary, the thermal conditions of the planet Saturn, supposed destitute of intrinsic heat, or of a heat imprisoning atmosphere, cannot be much above the absolute zero of temperature. Lavoisier, who clearly foresaw the eventual liquefaction of gases, upon examining what would take place if our earth were transported to the distance of Saturn from the sun, suggested the idea that our refrigerated atmosphere would alter its gaseous state and condense itself into a liquid or solid mass upon the planet's surface. The subsequent liquefaction of sulphurous acid gas by Monge and Clouet in 1800, that of chlorine by Northmore in 1805, and, above all, the liquefaction of oxygen, hydrogen, and carbonic acid gas by MM. Caillette and Raoul Pictet in 1877, is merely the experimental verification of a physical conception whose force lay in its anticipating the unknown.

As a consequence, we find that, in virtue of their great distances from the sun, the four superior planets, if not self-hot, would be deprived of atmospheres, comparable at least in composition to our own. The presence of gaseous envelopes round these worlds would thus imply relative youth in their planetary evolution.

XUM

Strong reasons have been adduced to show that Saturn is one of the youngest, if not the very youngest planet of our system. The chief of these is its low mean density. Density increasing with age, a very low mean density is only compatible with youth. "This noble ball," says Webb in his fascinating style, "has so little density that it would float like oak on water, which is actually heavier, and, therefore, if any were found there, would sink to its centre."*

The changes in the mottled appearance of the planet's belts, brought forward by modern discovery, is another argument in favour of its youth. At the distance of Saturn solar energy seems too enfeebled to produce the phenomena actually seen; so that we are obliged to have recourse, for their interpretation, to the assumption that the planet still retains a part of its original heat, and we have seen that intrinsic heat in a given stage of a planet's life is only a synonym of youth. But, inasmuch as the shadows of the satellites in transit across the planet have been repeatedly described as being quite "black," such heat is at best *dark* heat, the oscillations producing which send through the ether undulations of greater wave-length than those appropriate to vision.

The first feature which strikes the student when observing Saturn in a powerful telescope is the rapid waning of the luminosity of the globe towards the limb. This appearance, which is also observable on Jupiter and Uranus, is a necessary consequence of the law of irregular reflection or diffusion of light, according to which the intensity of the illuminated surface varies inversely with the angle formed by the incident rays with the normal to the surface. Such is the deportment of a white unpolished globe illuminated by a powerful distant light. Consequently, terrestrial analogies lead us to the probability that the visible surface of the major planets would seem to be composed of more or less uniform, dull oceans of precipitated vapours—clouds—with scarcely any light-scattering medium above.

Diametrically opposed phenomena are shown by the brighter limbs of the inferior planets, whose dazzling atmospheres extend high above the 'cloud region.' Here, as suggested by Sir William Herschel, the line of sight encounters an increased number of luminous particles towards the limb, whose luminosity is thereby, of course, increased.

In 1805, with a slight opening of the ring, Herschel drew attention to a peculiar appearance of the globe of Saturn, which presented itself as "square-shouldered." Various explanations have been given of this remarkable phenomenon, but none, to the writer's knowledge, that seems plausible. Thus Proctor speaks of Herschel's observation as a "discovery that the planet's outline occasionally fluctuates in such sort that instead of the normal ellipse we have abnormal peculiarities,"† and proceeds to explain the phenomenon by a hypothetical variability of Saturn's surroundings to the depth of *several thousand miles*, becoming at times transparent, at others opaque. Ingenious as the interpretation doubtless is, we must confess that it strikes us *à priori* as somewhat forced and unnatural. Strikingly abnormal planetary appearances are, as a rule, products of the most trivial causes, and rather than launch into the uncertainty of fearlessly explaining away what we know next to nothing about, we ought to keep our minds alertly vigilant to detect the unsuspected action of some elementary physical law. Optical science proves usually a valuable auxiliary in such cases, for more than once innoxious contrast effects have given birth to the most marvellous interpretations.* Returning to the question of the square-shoulder of Saturn, we see at a glance that the usual darkness of his polar cap (Fig. 1) must partly check irradiation, thus paving the way to an *optical* "square-shoulder." This ought to happen, and really happens, whenever the opening of the ring is not very considerable, and when the joint action of both the sombre polar caps is brought to bear in the production of the optical illusion.

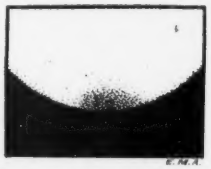

FIG. 1.—Saturn's Dark Polar Cap, 1895, August 9 (9¾ O. G., power 220).

The abnormal outline of the shadow cast by the planet on the ring next deserves our close consideration. Many eminent observers have seen this outline assume a form scarcely compatible with the theory. Proctor saw in this a confirmation of his suggestion of a variable outline of the ellipsoid, while Herr Wonaszek concluded that "the plane form of the system of rings . . . . . assumes a conical curve on which the shadow of a sphere can appear as a concave curve."† Somewhat different are the writer's impressions. The shadow has presented to him, during the last twelve years, nothing truly abnormal; nothing that could not be most thoroughly accounted for by the known laws of optics. The convexity towards the globe (Fig. 2) is only what we ought to expect (*a*) from the effect of irradiation and vagaries of vision in blunting the bright angles of the ring along the shadow, and (*b*) from the varying luminosity of the ring, and the consequent exaggerated effect of irradiation towards the outer edge of the interior bright ring—the brightest part of the system.

FIG. 2.—Irradiation and Contrast Effects in the Shadow of Saturn, 1890, May 26 (3-in. O. G., power 150).

The white spot bordering the shadow of the planet on the ring, to which Dr. Terby called the attention of the scientific world in March 1889, is another optical phenomenon. Although entirely illusory, this spot was so obvious a feature to the writer at the time as to be readily accessible to a three-inch telescope (Fig. 2). In 1894, with a moderate opening of the system, the spot was also very remarkable, this time on the northern surface of the ring (Fig. 4). In 1895 it was less distinct, while scarcely any traces of it were noted in 1896, 1897, and 1898. It would thus appear that a moderate opening of the system is, in some way, essential to the production of this appearance of contrast.

As in the case of Jupiter, the temperate regions of Saturn are marked by a dusky band of apparently variable intensity. The equatorial zone is separated from the temperate latitudes of both hemispheres by a prominent dusky belt, of which broad duplicity seems a characteristic feature. One

* "Celestial Objects," 4th ed., p. 172.

† "Old and New Astronomy," p. 627.

* Observers do not seem to pay sufficient attention to optical products generally, and to contrast effects in particular. Contrast explains the bright borders to the Martian "Seas," the exaggerated cusps of Venus in dichotomy, and I have recently shown (*Monthly Notices*, R.A.S., March, 1898) that the 225d. rotation period of Venus rests on a misinterpretation of contrasts between light and shade. The self-same reason which prevents our seeing stars by daylight masks the real surface of the planet Venus. Hence the hopeless defeat of all attempts to determine her rotation period by visual methods.

† *Bulletin de la Société Astronomique de France*, 1897, p. 485.

XUM

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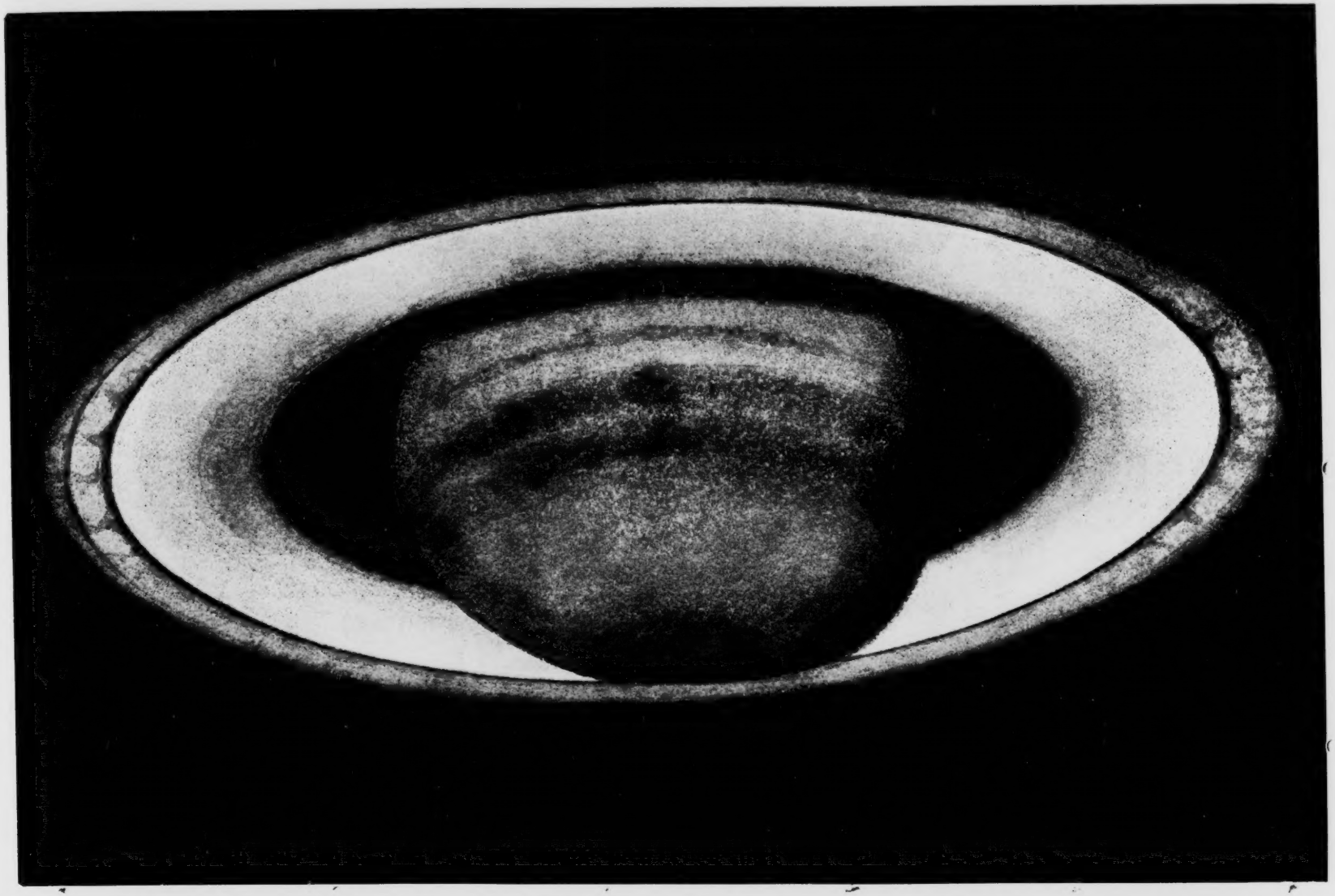
XUM



SATURN, 1898, September, 13d. 6h. 40m. G.M.T.

Reproduced from a Drawing made specially for KNOWLEDGE by Mons. E. M. ANTONIADI.

or two observers of great reputation have challenged the reality of this duplicity, and in this they were for a short time confirmed by the writer, at a time when his eyes had not the training necessary for the detection of such delicate details. It was subsequently found, however, that the broad appearance of this belt is merely an imperfect view of its really double structure. And as this conclusion has been subsequently confirmed by photography, dissent on this subject is necessarily silenced.

The equatorial zone is the brightest region of the planet, though its brightness falls far below that of the inner bright ring. A narrow band often marks the equator. The colour of the zone is a strong yellow, in which adequate aperture shows, as in the case of Jupiter, a decided "wool-pack" structure. At times, some of these cumuli become so brilliant as to offer easy marks for any rotational displacement of spots.

The rotation period of Saturn was discovered by the illustrious W. Herschel in 1793 from changes in the appearance of the famous "quintuple belt," in the planet's south hemisphere. From one hundred and fifty-four rotations, Herschel gave the value of 10h. 16m. 0·4s., "exact to much less than two minutes either way."*

For a long time Herschel's results remained unconfirmed, when, in 1876, Prof. Asaph Hall detected a bright spot in the equatorial zone. A careful discussion of his observations gave him the value of 10h. 14m. 23·8s. ± 2·30s.†

The subject was attacked with the most severe consistency in 1891 by Mr. Stanley Williams. Having obtained, between 1887 and 1891, nearly four thousand observations of transits of spots across the central meridian of Jupiter, this great observer was better prepared than anybody else for the investigation of the arduous problem. Mr. Stanley Williams saw not only the white spots in the tropical regions of Saturn, but, further, had the good fortune of seeing his persevering efforts crowned by the discovery of a series of dark spots on the great double belt, south of the planet's equator. The observations of four bright spots and a dark one, discussed by the late Dr. Marth, gave the value of 10h. 14m. 21·84s. In 1892, the bright equatorial spots gave to Mr. Williams the period of 10h. 13m. 38·4s. In 1893, the Brighton observer saw easily both the bright and the dark spots of the northern hemisphere, and confirmed, by observation, Proctor's suggestion to the effect that "the equatorial zone of Saturn has a rotation period measurably shorter than that of the non-equatorial zones."‡ Mr. Williams further found that the surface material of the self-same latitude did not rotate at a uniform period in different values of kronocentric longitude.§

These remarkable results have been confirmed in 1894. The comparison of the annual rotation periods determined from 1891 to 1894 showed a decrease in the period of rotation amounting to 1m. 46s. "This difference" says Mr. Williams, "means a very considerable increase in the velocity of motion of the surface material, amounting to sixty-six miles an hour. In other words, the great equatorial atmospheric current of Saturn was blowing sixty-six miles an hour more quickly in 1894 than it was in 1891."‖

The same sceptics whom we have seen denying the duplicity of the belts, questioned the reality of the spotted appearance of Saturn.¶ But, inasmuch as their observations have invariably dealt with "the most prominent features," it would seem that, in throwing doubt on the reality of details whose delicacy is beyond their reach, they are going beyond their own department, and their opinion is no longer of weight. The spots of Saturn have been seen by observers of great practical skill, among whom we might mention Messrs. H. MacEwen, at Glasgow, A. Henderson, at Liverpool, G. L. Brown, at Stirling, the Rev. P. H. Kempthorne, of Wellington College, and the late Rev. A. Freeman. At Juvisy the dark spots have been held steadily, and their rotation followed, by M. Camille Flammarion; also by persons who knew nothing about their existence. It was only after two years' fruitless attempts with the nine and three-quarter inch equatorial that the writer saw them in 1896, when the observation of three spots gave him 10h. 14·3m. for the rotation period.

This powerful array of evidence establishes the objective reality of the spots of Saturn on an indestructible basis. Their discovery is one of the most remarkable achievements in planetary work of our times. And when we recollect that the instrument used in their detection was only a six and a-half inch reflector, we deem it impossible to do adequate justice to the steady perseverance and unrivalled skill of Mr. Stanley Williams, whose name we feel assured will pass down to posterity in company with those of the greatest observers who have ever lived.

The question of the nature of the ring system, whose eccentricity to the globe is manifest at present* (*see* the Plate accompanying this paper), has been attacked by Laplace, to whose theory very valuable contributions were brought by two distinguished lady astronomers, Madame Sophie Kowalewski and Miss Dorothea Klumpke.† Bond and Pierce also investigated the subject, but it is to the genius of Edouard Roche and J. Clerk Maxwell that we owe our knowledge of the constitution of that marvellous configuration. As a result of his studies on the figure of a fluid mass submitted to the attraction of a distant point, Roche found, in 1849, that when a satellite, supposed of the same density as its primary, is situated at a distance of less than 2·44 radii, any ellipsoidal figure of equilibrium becomes impossible through the tidal action of the primary. The semi-axis major of the orbit of Mimas, the first satellite, being 3·10 radii, this moon could form and subsist; but the ring, being entirely within the theoretical limit (1·48 to 2·30), has actually remained in a state of cosmical dust.

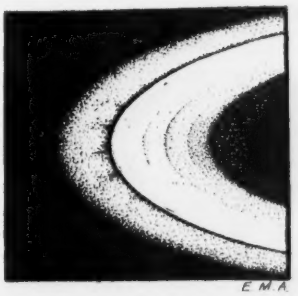


FIG. 3.—Amphitheatrical Gradations separated by Rarefaction Zones, seen on the Inner Bright Ring on 1896, April 18 (9½in. O.G., power 300).

Thus, for Roche, as well as for Clerk Maxwell, the only possible system of rings would be composed of a number of discrete particles revolving round Saturn with varying velocities—a theoretical conclusion, which the application by Keeler of the Doppler-Fizeau principle to the revolution of the ring has confirmed in such a striking manner. These particles are either united into a series of narrow

* *Philosophical Transactions*, 1794, p. 66.

† "Saturn and its Ring," App. II. to *Washington Obs.*, 1885, p. 15.

‡ "Old and New Astronomy," p. 624.

§ *Monthly Notices*, R. A. S., March, 1894. ‖ *Ibid*, May, 1895.

¶ Mee's "Observational Astronomy," App. II. to Second Edition.

* Since 1895 the writer invariably found that the eastern vacuity is greater than the western—a somewhat normal appearance.

† *Thèses présentées à la Faculté des Sciences de Paris pour obtenir le grade de Docteur ès Sciences Mathématiques*, par Mdlle. D. Klumpke. Paris, 1893.

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rings, or cross each other irregularly in their motions. The frequent observation of sub-divisions, permanent or otherwise, in the rings (Fig. 3) is thus only what should naturally be expected; but under such circumstances final disintegration is inevitable.

An interesting corollary of the discrete character of the system is the intimate relation existing between the grouping of the particles and the luminosity of the ring.

There where the particles are grouped nearer together (outer edge of inner bright ring), we have increased luminosity; there where they are more coarsely scattered (outer ring), the brightness is diminished. Should the particles be too widely strewn (dusky ring), then we have the conditions necessary for the production of transparency. There can be but little doubt that the outer ring is also slightly transparent; not, of course, to the extent of showing us the planet's limb through it, but still sufficiently transparent to render its shadow grey and not quite black (Fig. 4).

As its epithets of "crape ring" or "gauze veil" imply,

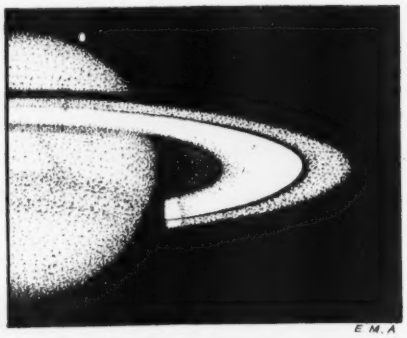

FIG 4.—Duskiness of Outer Ring's Shadow, suggesting the idea of Transparency. 1894, July 4 (9¾ in. O.G., power 220).

the dusky ring of Saturn has been hitherto considered as "one of the greatest marvels of our day."* But the remarks we have made on the subject of the wonders associated with the square-shouldered appearance of the planet, have warned us to be sceptical of irrational interpretations. Of explanations of the nature of the dusky ring the writer knows none, excepting "Burton's ingenious suggestion, that the separate particles, though brighter than the sky, may be less luminous than the ball."† But the very ingenuity of this assumption casts a doubt on its correctness.

We can scarcely believe (*a*) that one part of a system of discrete particles, having manifestly a common origin, is white, another grey; and (*b*) that the sombre meteors all managed to group themselves near the planet to the absolute exclusion of the white ones. The probabilities of such a state of things being natural are but few. "The moon," said Tyndall, "appears to us as if—

"'Clothed in white samite, mystic, wonderful;'

but were it covered with the blackest velvet it would still hang as a white orb in the heavens, shining upon our world substantially as it does now."‡

Starting from the hypothesis that the luminous diffusive power of the particles is everywhere the same, and seizing all natural conditions likely to be found here, we might perhaps scan the true nature of the "gauze" ring. We saw that the relation between the agglomeration of the particles and the luminosity of the ring implies that the bodies constituting the "dark" ring are more coarsely scattered than those constituting the bright rings. In this case the segments at the ansæ would be, just what they actually are in the telescope, parts of a nebular annulus; while, across the planet, the passage of the ring would be invisible *as far as the particles themselves are concerned.*

But, inasmuch as the stream casts its shadow on the globe of Saturn, every individual meteor yielding its own modicum of shade, we readily perceive that the trace of the "dark" ring across the planet would be a dusky shading, due solely to the shadow of the particles on the ball, a shadow which would be visible through the gaps separating that flight of meteors (Fig. 5).

The correctness of this theory may be checked by its consequences. Should the sun be higher above the plane of the ring than the earth, the breadth of the shadow across the planet would shrink along the minor axis; should the sun be lower than the earth, the breadth would be increased by the additional shadow of the inner edge of the bright ring. In both cases, however, the outline of the shadow cast on the globe would not be a rigorous continuation of the nebular ansæ. But, as the heliocentric latitude of Saturn cannot exceed 2° 30′, and as the proximity of the ring to the planet is very great, the slight differences of outline we have mentioned would, under all ordinary circumstances, be entirely masked by errors of vision.

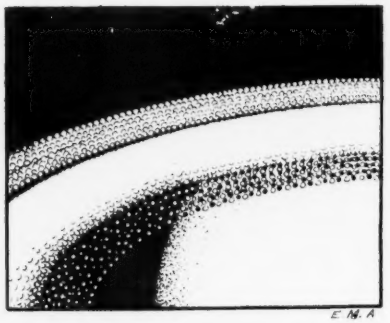

Fig. 5.—Diagram illustrating the writer's theory on the probable constitution of the Crape Ring. (Dimensions of particles and their shadows monstrously exaggerated.)

As a last consequence of the theory we are examining it ought to be expected that the darkness of the dusky belt across the globe would be, to a slight extent, a function of the opening of the system. When the value of the angle formed by the plane of the ring and the visual ray is small, the particles of the "dark" ring ought in an appreciable measure to hide their own shadow, while their apparently closer grouping would in this case slightly interfere with the usual transparency of the ring, a conclusion which seems to be actually corroborated by observation.

Science Notes.

Lord Iveagh has made two munificent offers to the nation, the fulfilment of which will involve a cost to the donor of a sum amounting to not less than half a million of money. The first offer, which has already been accepted, is that of a quarter of a million to be employed in the endowment of scientific research. It is explained in the following letter which was addressed to the Press on December 22nd by Lord Lister, the Chairman of the Council, and Sir Henry E. Roscoe, the Honorary Treasurer of the Jenner Institute of Preventive Medicine:—"We ask permission to announce in your columns a splendid offer in aid of scientific research which has been placed in our hands. British and Irish men of science have long

* Webb, "Celestial Objects": Saturn.

† *Ibid.* ‡ "On Light," 5th ed, p. 33.

deplored the fact that the opportunities in this country for research directed to the prevention of disease are not equal to those possessed by foreign nations. Lord Iveagh wishes to help in removing this reproach to our country, and, on the conditions named below, has offered the sum of £250,000 (two hundred and fifty thousand pounds) for the purposes of the highest research in bacteriology and other forms of biology as bearing upon the causes, nature, prevention, and treatment of disease. He has proposed to the council of the Jenner Institute (lately the British Institute) of Preventive Medicine—a body which includes leading men in medicine and allied sciences in the British Isles—that the donation shall be handed over to the institute on condition that in future the control and management of the affairs of the institute shall be placed in the hands of a new board of seven trustees—three of the seven to be chosen by the council of the institute, three by the donor, and one by the council of the Royal Society. The offer has been cordially accepted at a meeting of the council. The donor further proposes that part of the new fund shall be appropriated to the enlargement of the buildings of the institute at Chelsea, part to increasing the at present sadly inadequate salaries of the director and other members of the scientific staff, part to the expenses of administration and maintenance, and the remainder chiefly to founding valuable Fellowships and studentships, tenable for limited periods, for research either in the laboratories of the institute or in centres of outbreaks of disease, whether at home or abroad. The conditions on which these Fellowships and studentships may be held are not yet determined upon; but it is hoped to open them to all classes of Her Majesty's subjects. Lord Iveagh, in our opinion, deserves the gratitude of the nation for thus munificently providing for the cultivation in the British dominions of biology and allied sciences for the good of mankind in an institution which henceforth will compare favourably with any similar establishment in other parts of the world."

In a letter to the *Times*, far from hostile in spirit, Sir John Lawes and Sir Henry Gilbert criticise the statements made by Sir William Crookes in his address as President of the British Association on the wheat supply of the world, and it is satisfactory to learn that the outlook is not so gloomy as was depicted in that address. "That we may have considerable fluctuations in produce and in price," say these authorities, "the result of war, or of the vicissitudes of the seasons in different countries, is very probable; but we believe that there will always be a sufficient supply forthcoming for those who will find the money to purchase it at a remunerative price."

Prof. Chun, the leader of the German deep-sea expedition, has sent to Sir John Murray an account of the progress of the work. On the 7th August, 1898, in the cold waters of the Faröe Channel, from a depth of three hundred and twenty-two fathoms, the trawl produced a rich harvest of deep-sea sponges, sea-lilies, sea-stars, and sea-spiders. Many deep-sea crustacea and fishes which were taken in the dredge and trawl by earlier expeditions, and were therefore supposed to live on the bottom, have been proved to live a pelagic life, floating or swimming in the intermediate waters. Gorgeous *radiolaria*, violet-coloured jelly-fishes, large *astracoda*, the size of nuts, living gelatinous sea-slugs, strange cuttle-fishes, and large new sea-butterflies have been captured by the *Valdivia's* closing nets in the deep intermediate waters of the North Atlantic.

Mr. Charles W. Andrews, recently returned from Christmas Island (Indian Ocean), has given a detailed account of the expedition to the Royal Geographical Society. He describes the climate as delightful and healthy; there are no stagnant pools, and there is a fair supply of good water; forests are extensive, and many creepers and ferns lend beauty and variety to the scenery. There are only five species of mammals—two kinds of rats which swarm everywhere, a shrew mouse, and two bats; reptiles are few and small, and insects fairly abundant. There are several species of land crabs, and the robber crab is very plentiful, and if one sat down for a short time in the forest, at any spot, that spot speedily became the centre of a circle, and along the innumerable radii the crabs could be seen wending their way securely, if slowly, to the place of meeting around the sitter.

A scientific expedition under the leadership of Herr Meyer, the explorer, left Hamburg on the 1st December, 1898, for South Brazil and Argentina, where the party will conduct anthropological and geological researches. The expedition, which takes its own doctor, numbers thirty members, and will be absent for two years.

The medals of the Royal Society have this year been awarded as follows:—The Copley Medal to Sir William Huggins, for his researches in spectrum analysis applied to the heavenly bodies; the Rumford Medal to Prof. Oliver Joseph Lodge, for his researches in radiation, and in the relations between matter and ether; a Royal Medal to Dr. John Kerr, for his researches on the optical effect of electrical stress, and on the reflection of light at the surface of a magnetized body; a Royal Medal to Mr. Walter Gardiner, for his researches on the protoplasmic connection of the cells of vegetable tissues, and on the histology of plants; the Davy Medal to Prof. Johannes Wislicenus, for his contributions to organic chemistry, especially in the domain of stereochemical isomerism; and the Darwin Medal to Prof. Karl Pearson, for his work on the quantitative treatment of biological problems.

Dr. A. M. W. Downing, chief of the "Nautical Almanack" office, gives some particulars on the total solar eclipse of 28th May, 1900, which will be useful to those who contemplate an expedition to Algiers—a place easy of access and in the centre of the shadow.

The death of Mr. Edwin Dunkin, F.R.S., occurred on the 4th December, 1898, a gentleman whose name is familiar as the author of several books: "The Midnight Sky," "Familiar Notes on the Stars and Planets," and a work on "The Movement of the Solar System in Space," determined from the proper motions of one thousand one hundred and sixty-seven stars. He was born at Truro in 1821, and joined the staff of Greenwich Observatory while yet a youth of seventeen, and remained there nearly half a century. Mr. Dunkin was elected a Fellow of the Royal Astronomical Society in 1845; served as Secretary from 1871 to 1877, and in 1884 was elected President; he attained to the Fellowship of the Royal Society in 1876, and from 1879 to 1881 was a Member of the Council of that august body. Mr. Dunkin represented the Astronomer-Royal in several eclipse expeditions, conducted many important operations in determining the telegraphic differences in longitude of widely separated places, and he was the responsible agent in the famous pendulum experiments undertaken at Harton coal-pit, near South Shields, in 1854, by the Astronomer-Royal, with the object of ascertaining the mean density of the earth.

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British Ornithological Notes.

Conducted by HARRY F. WITHERBY, F.Z.S., M.B.O.U.

COMMON BUZZARD AND DOMESTIC FOWL.—The Buzzard on the right-hand side of the accompanying illustration was taken about seven years ago in Wales. In 1896, the bird laid a couple of eggs, which I took away and replaced by two fowl's eggs. She sat on these for a time and then eat them. In 1898 she again evinced a desire to nest, and I supplied her with materials as on the former occasion. She built a nest in a corner of the cage, which is about

twenty feet by eight feet by eight feet, and laid two eggs. I again substituted two fowl's eggs, one of which she hatched out, but the chick disappeared, and whether she eat it or not I do not know. As the bird still seemed inclined to sit, I put three fowl's eggs in the nest. Two of these were hatched, but one chicken died. The other is the one shown on the left of the Buzzard in the illustration. I fed the chickens on hard-boiled eggs, chopped small, and the Buzzard used also to eat this food. Gradually the Buzzard fed the chicken on meat, and now the latter feeds on both meat and corn; it will not, however, eat maize. The chicken and Buzzard roost side by side on the perch at night, and are most friendly. The chicken is fond of birds and has even tried to help the Buzzard to kill them. It is now large, and appears to have thriven well on meat.—ALAN F. CROSSMAN, St. Cuthberts, Berkhamsted, Herts.

HONEY BUZZARD AT PETERHEAD.—There was shot at Kinmundy, on September 19th, an immature specimen of the Honey Buzzard. The plumage was dark brown, with a slightly lighter shade on the cheeks, throat, and belly; there were three bars of a slightly darker colour on the under side of the tail feathers; these feathers were likewise tipped with grey. The plumage was very close, and when separated showed abundance of white. There was one shot at Pitfour, in the same neighbourhood—probably a young male—seven or eight years ago, and is in the possession of the gamekeeper there.—WILLIAM SERLE, Musselburgh.

WOOD-SANDPIPER IN CO. MAYO.—At a meeting of the British Ornithological Club held on November 16th, 1898, Mr. Howard Saunders exhibited, on behalf of Mr. W. Drury, a specimen of the Wood-Sandpiper (*Totanus glareola*), shot by the latter near Lough Cullin, in Co. Mayo, Ireland, on September 5th last. Only three examples of this species have previously been recorded from Ireland, and all of them from one locality, viz., in Co. Wicklow.

GREATER SPOTTED WOODPECKER AT PETERHEAD.—On the 30th October I was shown two woodpeckers that were shot the previous day at Grange Gardens, behind the town. They were both young males; on the one the cardinal colour was developing on the head, and showed fully on the vent, but the white on the upper lesser wing coverts did not show largely. The head of the other showed the cardinal colour fully, as likewise the white on the lesser wing coverts, but the cardinal colour on the vent only slightly.—WILLIAM SERLE, Musselburgh.

Spotted Crake in County Down (*The Field*, November 19th, 1898).—"J. R." reports that he shot a Spotted Crake, which is rare in Ireland, at Seaforde, County Down, on November 5th, and that the specimen is now in the hands of Messrs. Sheals, taxidermists, of Belfast.

Vernacular Names of Birds (*The Naturalist*, December, 1898).—Interesting lists of vernacular names of birds, by Oxley Grabham, F R. Collins, and Max Peacock, appear in this number.

Ospreys near London (*The Field*, December 3rd, 1898).—Mr. J. E. Harting gives here an account of the various visits of the Osprey to the neighbourhood of London. "Best," in a letter to the *Standard*, of September 20th last, described the actions of an Osprey, which he watched at the Penn Ponds, Richmond Park, on September 16th. Dr. Albert Günther saw an Osprey soaring over Kew Gardens on September 15th, 1898. Mr. Harting gives many records of Ospreys shot or seen near London since 1855, and considers that "these instances serve to show that Ospreys may be annually looked for near London during the autumn months."

Additional Notes on the Great Auk or Garefowl. By Symington Grieve (*Transactions of the Edinburgh Field Naturalists' and Microscopical Society*, Vol. III., Part 7).—These notes are additional to a paper printed in Part 6 of the *Transactions* of this Society. One newly recorded skin, belonging to M. Le Baron de Vilmarest, of Nielles-les-Ardres, is specially dealt with.

A Pet Cuckoo. By Charles Campbell (*Transactions of the Edinburgh Field Naturalists' and Microscopical Society*, Vol. III., Part 7).—We have here an account of a cuckoo which has been in captivity for over two years.

All contributions to the column, either in the way of notes or photographs, should be forwarded to HARRY F. WITHERBY, *at 1, Eliot Place, Blackheath, Kent.*

Notices of Books.

Birds of the British Empire. By Dr. W. T. Greene, F.Z.S. (The Imperial Press.) Illustrated. 5s. net. It has never been our misfortune to criticise a more inaccurate book than the one before us. Where the author has obtained his information we know not, but, with so many standard works on ornithology at command to refer, it is most astonishing how Dr. Greene could have filled his book with such startling errors. The following are two samples of the author's ornithology:—Page 23, "The Pied Wagtail is only found, out of Britain, in the Scandinavian peninsula." The Pied Wagtail is found in Denmark, Holland, Belgium, France, Portugal, and other countries. Page 154, speaking of the Knot, the author says: "Some, however, remain to breed." The first and only authenticated eggs of the Knot were only lately discovered in the Arctic regions. Besides containing a number of glaring errors like the above, the book is very carelessly constructed. For instance, descriptions of many birds which should have been included are omitted, and many which are included should have been omitted. Long and often most inaccurate descriptions of the plumage of each bird are inserted, whereas it is only necessary in many cases to say how one bird differs from another. In most cases the author describes the summer plumage, but this is only to be guessed, for no mention is made either of summer or winter.

Eclipses of the Moon in India. By Robert Sewell. Continuation of the "Indian Calendar." About a year ago we noticed the appearance of the "Indian Calendar," a volume of the utmost importance to those engaged in the decipherment of Indian inscriptions and the compilation of Indian history,

and also in the Indian Government offices and judicial courts. That work contained tables of all the eclipses of the sun visible in India for a period of one thousand six hundred years, and it has now been supplemented by tables of the lunar eclipses for the same period (A.D. 300 to 1900); the calculations being, as in the chief volume, based upon Von Oppolzer's *Canon der Finsternisse*. We heartily welcome this completion of so valuable a work. We regret to notice the death of the Pandit Sankara Balkrishna Dikshit, who collaborated with Mr. Sewell in the "Calendar," and who rendered assistance in the present supplement to it.

An Introduction to the Science and Practice of Qualitative Analysis.—Inorganic. By Chapman Jones, F.I.C., F.C.S. (Macmillan.) Illustrated. 6s. It is fitting that Mr. Jones should incorporate the words "Science and Practice" in the title of his book, for it is just this feature of reducing the numberless operations of the analytical chemist to a scientific, as distinct from the mere empyric form, which constitutes the value of the work. Indeed, considering that there are scores of books on qualitative analysis already in the market, nothing less than a radical innovation of the kind in question would be sufficient to justify the addition of one more to the already long list. We are at one with Mr. Jones where he says that "for teaching the *method* of work, it is not only unnecessary but undesirable to attempt to include either all classes of compounds, or all the reactions of those that are considered." The object of all teachers should be to help the student to acquire a sound method rather than to fill his mind with innumerable isolated reactions, so that, understanding the principles of analysis, instead of enslaving himself to the mystic rule-of-thumb routine, he can easily extend his work to other substances than those set for practice in the laboratory. We have known students quite helpless, after a long course of instruction, to set about the investigation of an unknown mineral, where there is but little externally to indicate the nature of its composition. This weakness is due to the fact that the student, in general, acquires his analytical knowledge by operating on bodies of known composition, which serve as a sort of alphabet for the construction of words—words, which if properly put together, will spell the composition of the body under examination. Now, in the book before us, the author has put forth his utmost powers to concentrate the light of reason on every experiment, observation and inference; from innumerable reactions he evolves an orderly system—a system that may be adapted to various circumstances, and the student is encouraged to consider the tables given as guides rather than as rigid rules, when he has had a little experience and can judge for himself.

The Parallaxes of 61^1 *and* 61^2 *Cygni.* By Dr. Herman Davis. (New York, 1898.) This is No. 13 of the series of memoirs upon the reduction of the measures of the photographic plates taken by Dr. Lewis Rutherfurd in the years 1871–1874, and which are now being published by the Observatory of Columbia University, New York. The high value of these photographs is now widely recognized, but several points of especial interest are brought out in Dr. Davis's paper. In the first place it was found that the probable error of an observation in the displacement on the arc of a great circle is little greater in measures of angle than of distance. Secondly, the parallax is different for the two components 61^1 and 61^2.

$$\text{For } 61^1 \text{ it is } + 0{\cdot}360'' \pm 0{\cdot}0146''.$$
$$\text{For } 61^2 \text{ it is } + 0{\cdot}288'' \pm 0{\cdot}031''.$$

This bears out the opinion of Prof. Burnham that this pair forms only an optical double, and that no true orbit can be drawn through their positions. But since the two stars have very nearly the same velocity in space, Prof. Davis advances Wilsing's theory, that there may be a third dark body round which 61^1 Cygni revolves. Incidentally, Prof. Davis brings a very serious indictment against the value of the Oxford parallactic results. "I have examined," he says, "the eight sets of normal equations given in the work on 61 Cygni, pages 17-63, and among the eight sets have not found one which is correct in every quantity. This criticism applies not only to the normals for 61 Cygni, but for many of the other stars as well."

Weather Lore. Compiled and arranged by Richard Inwards. (London: Elliot Stock.) Illustrated. 7s. 6d. This is the third edition of a work intended to present a complete view of weather science from its traditionary and popular aspects. It contains two hundred and four pages of proverbs, curious rhymes, quaint sayings, archaic wise-saws, and out-door rules, and will be of especial interest to the man whose good fortune enables him to live in the country. The volume, in addition to these interesting features, contains the essence of observations made by close observers of the skies, and has an instructive picture of the forms of clouds occurring at different altitudes. It is only necessary to note the conversations which one overhears or takes part in during a single day to convince one's self of the widespread nature of these sayings about the weather. Who has not heard "Plenty of berries indicates a severe winter," p. 184, and yet, since the berries, of course, indicate *past* conditions and *not future* ones, it is difficult, unless providential foresight is imported into the case, to account for its origin. There are many sayings with which one is familiar, and which defy any rational explanation, but the reader must be referred to Mr. Inward's exhaustive and interesting collection itself in order to discover how trustworthy, and also how contradictory, weather predictions preserved in folk-lore can be.

Remarkable Eclipses. By W. T. Lynn, F.R.A.S. (London: Edward Stanford, 26 & 27, Cockspur Street, Charing Cross, S.W.) 1898. Third Edition. Revised. The success of Mr. Lynn's convenient and carefully written little handbooks is apparent in the rapidity with which successive editions are called for. The first edition of this summary of the leading facts connected with the chief eclipses of history appeared in 1896, and the third is now before us. A brief notice of the two last total solar eclipses, 1896 and 1898, and of the circumstances of the two approaching ones are included in it.

Introduction to Algebra. By G. Chrystal, M.A., LL.D. (Adam & Chas. Black.) 5s. According to the author of the book before us the old methods of teaching algebra are at fault, and intended rather for the solution of examination problems than for the purposes of every-day life. We are convinced that Prof. Chrystal has made a refreshing departure, and although there is a rather forbidding appearance about the treatise, students may take heart, for the new method of treatment of the various theorems of algebraic science we think will gain supremacy over the old systems of teaching algebra. A mathematical truth is not made part of the mental furniture of a pupil by merely furnishing him with an irrefragable demonstration; he must see not only where it succeeds, but where it fails to apply, and this book will contribute towards that end.

Practical Mechanics. By S. H. Wells. (Methuen & Co.) Illustrated. 3s. 6d. The Battersea Polytechnic, up to a recent date, was almost the only institute in London which contained a mechanical laboratory, furnished with the apparatus for verifying all the principal laws of mechanics by the students themselves. We therefore welcome a text-book based on the course of study pursued in that laboratory, and cannot but think such a book will be a substantial aid to the principals of other institutes in combining a course of practical mechanics with the ordinary lectures. The text is written in an intelligible style, and is illustrated in a suitable manner by photographs of the actual apparatus used at the Battersea Polytechnic. With the help of this book a teacher may convey information which the student can assimilate without that verbose waste of energy which characterises the work of many preceptors.

Social and Political Economy. Essays and Letters by Thos. Judge. Edited by his son, T. Geo. Judge. (London: Simpkin, Marshall & Co.) 3s. 6d. We cannot discover any adequate reason for the publication of these essays and letters, which are as discursive as they are inconclusive, and we fear must disappoint the modest hope of their editor, that they "may introduce some light, however small," into the consideration of some interesting and important subjects.

Handbook for Literary and Debating Societies. By Laurence M. Gibson. (London: Hodder & Stoughton.) 3s. 6d. A useful volume for the purpose in view, containing an outline of the leading arguments on both sides of a large number of subjects, together with a list of references in each subject.

An Introduction to Practical Physics. By D. Rintoul. (Macmillan.) Illustrated. 2s. 6d. Based on the laboratory notes which have been in use at Clifton College for some years, this book is intended for beginners—a book which "will present no difficulty to the average boy" of thirteen or fourteen years of age, and "all the experiments described are capable of being performed with the most simple and inexpensive apparatus." An inspection of the contents does indeed indicate that the author has contrived to extract a maximum amount of practical knowledge out of a minimum outlay in the way of materials, and although there is little evidence of originality of

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treatment and disposition of facts, the admirable illustrations and precise instructions for verifying the fundamental principles of physical science are sufficient to commend the work to the preceptors in our schools and colleges.

Provident Societies and Industrial Welfare. By E. W. Brabrook, C.B., Chief Registrar of Friendly Societies. The Victorian Era Series. (London: Blackie & Son.) 2s. 6d. An experience which is unique, and a sympathetic treatment, born of long and intimate acquaintance with the facts, are the invaluable aids which Mr. Brabrook brings to bear upon the subject on which he writes so well. There is no more honourable record in our history than that of the industrial population of our country in regard to provident societies and savings banks, and the official position of the author of this invaluable work will really tend to make the book a sort of informal State document, dealing in a most comprehensive manner with a subject of the highest importance.

Photograms of 1898. Illustrated. 1s. net. (Dawbarn & Ward.) This well-known annual from the editors of the *Photogram* contains a careful and well-judged selection of the year's work in photography. The bulk of the volume consists of a collection of beautiful photographs, which are duly criticised in the text. One or two general articles complete a capital photographic record of 1898.

How to make Lantern-Slides. By S. L. Coulthurst. 1s. (Dawbarn & Ward.) To those who really require a new handbook on the above subject, we can recommend this one, which is up-to-date and clearly expressed. We might remark that twenty or so of its pages are filled with various developing formulæ.

The Reliquary and Illustrated Archæologist. (Bemrose.) 12s. net. We have in former years had occasion to point out the many claims to our regard of this quarterly journal and review, the bound volume of which for 1898 is before us. We have nothing to retract from what we then said, and can only reiterate with, perhaps, more pronounced emphasis, that the journal is worthy of the attention of all persons interested in the study of the early pagan and Christian antiquities of Great Britain, mediæval architecture and ecclesiology, the development of the arts and industries of man in past ages, and the survivals of ancient usages and appliances in the present. The wide margins, superb printing, and beautiful illustrations in wood and reproductions from photographs, all combine to make the volume a choice possession.

First Stage Inorganic Chemistry (Practical). By F. Beddow, D.SC. (Clive.) Illustrated. 1s. Dr. Beddow's book is one of the many inspired by the innovations made in the syllabus of the Science and Art Department. It is a neat, cheap, and excellent little manual in every way for its purpose, and if the many branches of chemistry dealt with in the space of some one hundred and sixty pages are, so to speak, an attempt to make the less contain the greater, that is the fault of the Department rather than the author, who has managed the business of compression with skill, and succeeded in making intelligible a wide range of facts which would tax the powers of most authors with much more space at their disposal. The ordinary operations of fitting up apparatus, preparing gases and compounds, qualitative analysis and quantitative analysis, all come in for a share of the author's attention, and any one who carefully works through the book will acquire a sound knowledge of the groundwork of chemical manipulation.

All photographers should obtain Mr. W. Tylar's 1898 Catalogue of Photographic Specialities and Appliances. Price 6d. The Catalogue consists of over two hundred full and well-illu-trated pages, containing, amongst other information, full particulars of many novelties and improved patterns.

BOOKS RECEIVED.

Annals of the Lowell Observatory, Vol. I., Observations of the Planet Mars during the Opposition of 1894-5. By Percival Lowell, Director of the Observatory. (Houghton, Mifflin & Co., New York.)

Quæro: Some Questions in Matter, Energy, Intelligence and Evolution. By Dr. James H. Keeling, F.R.C.S. (For Private Circulation.)

Whitaker's Almanack, 1899. 2s. 6d.

Earth Sculpture. By James Geikie, F.R.S. (Murray.) Illustrated. 6s.

The Life and Letters of Lewis Carroll. By Stuart Dodgson Collingwood, B.A. (Unwin.) 7s. 6d.

Michael Faraday: His Life and Work. By Prof. Silvanus Thompson. (Cassell.) Portrait. 3s. 6d.

The Way the World Went Then. By Isabella Barclay. (Stanford.) Illustrated. 4s.

On the Springing and Adjusting of Watches. By F. J. Britten. (Spon.) Illustrated. 3s.

The Magic Lantern—Nutshell Series. (Iliffe.) 6d.

Flashlights on Nature. By Grant Allen. (Newnes.) Illustrated. 6s.

A New Astronomy. By David P. Todd. (Sampson Low, Marston & Co.) Illustrated. 7s. 6d. net.

The "Mechanical World" Pocket Diary and Year Book, 1899. 6d.

London University Guide and Calendar, 1898-9. (Univ. Corr. Coll. Press.) Gratis.

Tutorial Algebra: Advanced Course. By W. Briggs and G. H. Bryan. (Clive.) 6s. 6d.

Der Ursprung der Afrikanischen Kulturen. By L. Frobenius. (Borntraeger, Berlin.)

Trigonometry at a Glance. By G. W. Usill and F. J. Browne. (Philip & Son.) 2s. net.

The "Queen" Almanack, 1899. 1s.

A Determination of the Ratio of the Specific Heats at Constant Pressure and at Constant Volume for Air, Oxygen, Carbon-dioxide, and Hydrogen. By O. Lummer and E. Pringsheim. (Smithsonian Collection.)

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

THE NEW OBSERVATORY AT KODAIKANAL.

To the Editors of KNOWLEDGE.

SIRS,—The readers of KNOWLEDGE will perhaps be interested with a short account of a visit I made yesterday to the new observatory which is building at Kodaikanal. On my way to Shang-hai, I could not help breaking the voyage to pay a visit to the observatory of old repute at Madras, where the late Mr. Pogson did, during so many years, such valuable work in planet discovery, as every astronomer knows. Mr. Michie-Smith, now in charge of the Government Observatory, kindly suggested that on my way back to Tuticorin I should pay a visit to the new buildings at Kodaikanal, where he intends going himself in January next, when the astronomer's house will be ready to receive both his apparatus and himself. As many amateur astronomers already know, the new observatory will stand on the highest point of the Pulney Hills, a branch of the Southern Ghats, protruding on the western part of the Madura district in the Presidency of Madras. Its geographical co-ordinates are, approximately, Lat. 10° 14′ N., Long. 77° 33′ E. The distance from the Ammayanayakanoor station, on the S. I. R., to the foot of the Pulney Hills is thirty-one miles. The trip is made in about seven hours in the Indian cart. The long two-wheeled vandy is indeed mounted on springs, but these springs are oftentimes of very little use to diminish the pitching and tossing one has to suffer more or less on every Indian highway. The sturdy little bullocks, however, do their work well. From the "Tope" at the foot of the hills up to Kodaikanal, another twelve miles, is done on horseback in about four hours. The fatigue this old-fashioned style of travelling necessarily implies is splendidly recompensed when one reaches the dam of the lake, and still more when some hundred or a hundred and fifty feet higher one gets a general view of the lake itself and of the surrounding groves and villas. Owing to its high level above the sea, ranging from seven thousand to seven thousand eight hundred feet, this delightfully cool hill-station becomes more and more every year a favourite sanitorium for European residents of South India. Many of the cool-breeze seekers took their afternoon walk this year, I am told, in the direction of the new observatory.

The observatory stands a good mile distant from the west end of the basin-shaped valley, the bottom of which has been transformed by a dam into a handsome irregular lake. From the site chosen for the observatory, which is reported to be seven thousand seven hundred feet high, one has an extensive view of the plains of Madura in the east, where at sunset on fine days the elevated gopurahs of the great Vedic Temple may be clearly distinguished.

An irregular line on the horizon to the north marks the place where the far distant range of the Nilgherries lies, the rivals of the Pulney Hills. It was a question for a time of erecting the new elevated Indian observatory on the Nilgherry range, but the annual records of the necessary climatic conditions carefully observed in both places turned the balance in favour of the latter, for which the following data, as published by Mr. Michie-Smith in the *Publications of the Arts Society of the Pacific*, were reported in a local paper in June, 1895.

The mean daily temperature varied in one year from 54·2° F. in December to 62·2° F. in May, the mean for the year being 58·5° F. The mean humidity varied from forty-seven per cent. in March to eighty-three per cent. in August, the mean for the year being seventy-two per cent. The actual number of days on which ·01 inch and upwards of rain fell was one hundred and fifty-five, distributed through the twelve months thus :—

4, 5, 3, 16, 19, 19, 21, 24, 8, 21, 7, 8.

The total rainfall was 47·53 inches, but the average over a number of years, for a station a mile and a half distant, and nearer the edge of the cliff, was sixty-one inches. There were two thousand and fifty-six hours of bright sunshine throughout the year, and "my own experience," said Mr. Michie-Smith, "during a number of short visits, is that a night which remains cloudy throughout is very rare, and that a large proportion of the nights are brilliantly clear."

The building is erected on the rock, and has the form of an irregular cross, the main branch of which is shorter than the arms, and lies due east and west over a total length of seventy-two feet outside. The two arms are stretched north and south, symmetrically covering together a total length of eighty-eight feet. Each of them is terminated by a tower sixteen feet inside diameter and nineteen feet high, of which seven only remain to be completed. The upper floor of the observation room will be reached in each by an easy winding staircase, in small hexagonal towers, protruding symmetrically on the eastern side. The two arms will be completed first, and the towers will in March next be ready to receive their hemispherical domes, covered in papier-maché, the iron frames of which will not find their way up to the observatory without some trouble, as nothing is carried from the plain but by coolies or ponies. The remainder of the building has just now risen two or three feet above the foundation, but further directions must be waited for before the work can be continued. Whatever be altered, one thing now partly begun will remain, the spectroscopic room at the west end or head of the cross. The rays, either solar or stellar, it will admit for investigation, will be reflected by a clockwork polar heliostat, at the top of a long earthenware tube, of one inch to two inch bore, placed due north and south, on iron brackets, along the front part of the north tower. They will be analysed by a Rowland grating spectroscope, constructed by the late A. Hilger. The instrument is actually at Madras. Although the present intention is to study solar physics only, it is very probable that the astronomer in charge of such a favourably situated observatory will not be satisfied with this, but will also study stellar physics. Eye-witnesses alone can realize what nights are on tropical hills at this height, and my personal experience of three months spent on these hills ten years ago would induce me to speak in enthusiastic terms. Not once alone did I see Jupiter shining in such a manner, from near the zenith, that it cast on white paper a well-defined shadow of a hair, and its light passing through the foliage of the trees showed on the ground a shadow as neatly defined as if produced by an electric arc without diffusing globe. And yesterday evening, Venus, which attained on the 21st instant, its maximum of brilliancy after the "conjunction," cast, in spite of a brilliant six day old crescent moon, on a white wall a definite dark shadow of pillars supporting a verandah. The number of stars visible to the naked eye when the moon does not light up the atmosphere can be conceived only by those who have seen it for themselves. The first report of the Kodaikanal Observatory will contain interesting details on this subject, and stand advantageously in comparison with reports from other high-level observatories. Let us hope that when communication with Kodaikanal is cheaper owing to the railway line to be opened in January next from Ammayanayakanoor to the Tope, and a cable elevator worked by electric power which a Madras firm proposes to stretch over the Pambar falls and valley up to Kodaikanal, the trustees of the Observatory will be bolder to extend their work, and leave no advantage of so favourable and exceptional a position unused.

R. DE BEAUREPAIRE LAUVAGNY, S.J.
Astronomer of the Zi-ka-Wei Observatory.

Kodaikanal, India,
21st October, 1898.

[May I take the opportunity of Father Lauvagny's account of the important enterprise now progressing under Prof. Michie-Smith's able direction, to correct an error which crept into my description of the instrument employed by the latter during the late solar eclipse at Salidol, India? (KNOWLEDGE, July, 1898, p. 156.) Prof. Michie-Smith's telescope was not pointed to the Sun, but to the Pole, being placed parallel to the Earth's axis, and fed by a heliostat.—E. WALTER MAUNDER.]

VARIABLE STARS.

To the Editors of KNOWLEDGE.

SIRS,—Among variable stars of long period there are few that stand more conspicuous for changes in colour and fluctuations of light than S. Virginis and R. Hydræ. And the interest in them is increased from the fact that they remain, in this latitude at least, a long time in view and within the power of small optical instruments. These stars have grown in interest in the last three or four years, and for these reasons, and also from the fact that R. Hydræ does not remain long above your horizon, I submit the following ephemerides :—

S. VIRGINIS.

1898.	Mag.	1898.	Mag.
May 7 ...	9·00	June 15 ...	6·8
„ 9 ...	8·90	„ 20 ...	6·7
„ 12 ...	8·80	„ 22 to 26 ...	6·6
„ 14 ...	8·70	„ 28 ...	6·3
„ 15 ...	8·65	„ 29 ...	6·4
„ 16 ...	8·60	July 1 ...	6·6
„ 17 ...	8·40	„ 2 ...	6·8
„ 18 ...	8·30	„ 5 ...	6·35
„ 19 ...	8·30	„ 6 ...	6·15
„ 22 ...	8·1	„ 9 to 14 ...	6·5
„ 23 ...	8·0	„ 15 ...	6·4
„ 26 ...	7·9	„ 17 ...	6·6
„ 27 ...	7·8	„ 18 ...	6·7
„ 28 ...	7·8	„ 20 ...	6·9
„ 29 ...	8·1	„ 23 (very red)	
„ 30 ...	8·0	„ 27 ...	6·7
„ 30 ...	7·8	„ 28 ...	6·8
June 2 ...	7·3	„ 29 ...	6·9
„ 5 ...	8·05	August 1 ...	7·15
„ 6 ...	8·6	„ 3 ...	7·0
„ 7 ...	8·25	„ 5 ...	7·4
„ 8 ...	7·8	„ 7 ...	7·15
„ 10 ...	7·5	„ 10 ...	7·2
„ 12 ...	7·0	„ 14 ...	7·4
„ 14 ...	6·9		

XUM

The maximum which was computed for June 17th seems to have occurred July 6th, or twenty days late. The movements of the star were very perplexing, but not more so than those of

R. HYDRÆ.

1898.		Mag.	1898.		Mag.
May 17	...	7·65	June 26	...	5·20
„ 18	...	7·50	„ 29	...	5·10
„ 23	...	7·35	„ 30	...	5·15
„ 28	...	7·20	July 1 to 8	...	4·90
„ 29	...	7·15	„ 9	...	5·00
„ 30	...	7·10	„ 10	...	5·10
June 5	...	6·80	„ 12	...	4·90
„ 6	(very red)		„ 17	...	5·20
„ 10	...	6·70	„ 18	...	5·00
„ 12	...	5·50	„ 19	...	5·20
„ 14	...	5·30	„ 28	...	4·95
„ 17	...	5·20	„ 29	...	5·10
„ 22	...	5·10	August 1	...	5·15
„ 23	...	4·95			

The maximum was predicted for June 14th; apparently it may be placed on July 4th, or twenty days late. I have hesitated in showing a discrepancy of over a magnitude in this star on June 12th until, looking up its record, I found a similar discrepancy in Mr. Henry M. Parkhurst's record for 1897. See *Astronomical Journal*, No. 421, p. 99, where he says, "The discrepancy of a magnitude, 1897, April 15, is neither a typographical or clerical error." In this case, as in that of the fluctuations of Mira three or four years ago, finding myself in the best company, the figures are submitted to the common arbitrator.

There were many other observations of both stars made, but only definite changes are given.

o Ceti (Mira) reached a brilliant maximum, 1898, October 3rd, at 2·2 magnitude.

The star rose this season at later hours than I can keep, but I lost no available opportunity for an observation. My dates and estimates are as follows:—

o CETI (MIRA).

1898.		Mag.	1898.		Mag.
August 20	...	5·40	October 7	...	2·35
„ 21	...	5·20	„ 8	...	2·30
„ 28	...	4·80	„ 9	...	2·30
„ 29	...	4·70	„ 10	...	2·65
Septem. 4 (2 a.m.)		4·30	„ 11	...	2·55
„ 4 (10 p.m.)		3·90	„ 12	...	2·65
„ 7·8	...	3·70	„ 14	...	2·70
„ 13-14	...	3·2	„ 15	...	2·75
„ 15-16	...	3·15	„ 24	...	3·10
„ 17	...	2·95	„ 26	...	2·95
„ 18	...	3·05	„ 28	...	2·96
„ 22	...	2·80	„ 30-31	...	2·96
„ 22	...	2·85	Novem. 1·2	...	3·10
„ 23	...	2·70	„ 3	...	3·15
„ 24 (4 a.m.)		2·70	„ 5	...	3·20
„ 25 (4.30 a.m.)		2·70	„ 6	...	3·35
„ 25 (10 p.m.)		2·70	„ 7	...	3·45
„ 26 (3 a.m.)		2·30	„ 11	...	3·60
„ 26 (10 p.m.)		2·70	„ 13	...	3·45
„ 27	...	2·70	„ 14	...	3·50
„ 28 (4.40 a.m.)		2·70	„ 16	...	3·65
„ 28 (9 p.m.)		2·70	„ 17	...	3·80
October 2 (moon)		2·30	„ 18	...	3·80
„ 3 (max.)		2·15	„ 19	...	3·85
„ 4	...	2·10	„ 22	...	3·90
„ 5	..	2·35			

Following the terms of the second catalogue the maximum was due July 27th; it occurred October 3rd, about sixty-eight days late.

The seeming fluctuations were of a minor character, and may reasonably be charged to errors of observations; they may occur yet. Mira does not reach the meridian till near midnight, so there will be an opportunity to follow it down.

COMPARISON STARS USED.

66 Ceti	...	5·65	δ Ceti	...	4·20
70 „	...	5·62	α Piscium	...	3·90
ν „	...	5·20	γ Ceti	...	3·60
ξ^1 „	...	4·74	α „	...	2·50
ξ^2 „	...	4·50	β „	...	2·30

Memphis, Tenn., DAVID FLANERY.
14th October, 1898.

THE SUNSPOT PERIOD.

To the Editors of KNOWLEDGE.

SIRS,—In his very interesting article on "The Great Sunspot and the Aurora," which appeared in KNOWLEDGE, for October, Mr. Maunder intimates that the last spot maximum occurred in 1893, which I do not for one moment doubt. He then suggests that the approaching minimum will be reached about two years hence, or, in something less than seven years after the maximum. He is fully competent to make such a statement. Once more. In the *Journal of the British Astronomical Association*, Vol. I., No. 2, page 91, he is quoted as stating that the last sunspot minimum fell in 1889. Again, this accords with my own humble experience. But what puzzles me is to know how the "rule" mentioned in the first paragraph of the October KNOWLEDGE article is established. Are we to understand that the interval between minimum and maximum is generally between four and five years; and that the period separating maximum from minimum usually approximates to seven years? Or, are we simply to take it that the passage from minimum to maximum, as a rule, requires less time than does the opposite phase of the phenomenon? WILLIAM GODDEN.

38, Burrard Road, West Hampstead, N.W.,
19th November, 1898.

TREE STRUCK BY LIGHTNING.

To the Editors of KNOWLEDGE.

SIRS,—Perhaps some of your readers will kindly tell me what actually takes place when a tree is struck by lightning? I have in my mind a big ash tree which this summer was completely riven in two and split into match wood, and a large arm torn entirely off; what is the force which has been exerted? Is it that all the sap and liquid has been instantaneously turned into steam by the enormous heat produced, causing the wood to swell and burst; or what is the force exerted?

October 16th, 1898. A. C.

ERRATA.—In the December, 1898, number of KNOWLEDGE, on page 277, column 2, line 5 from bottom, for "crescends," read "crescendo"; line 3 from bottom, for "claricinists," read "clavicinists"; page 278, line 1, for "Ramsau," read "Rameau"; line 6, for "crescends," read "crescendo."

THE OVIPOSITOR OF A BEETLE (BAPTOLINUS ALTERNANS) AND THE TEETH OF THE DUNG FLY.

By WALTER WESCHÉ.

BAPTOLINUS alternans is a small beetle, about three-eighths of an inch in length. Mr. Waterhouse tells me it is rather rare, but he has found it in decaying wood, and this remarkable ovipositor, consisting of a number of curiously formed hooks, seems well adapted for scratching out holes in such a substance. The specimen figured was found in a garden

in South Hampstead, on the edge of some turf, and I captured the male—which is precisely like the female externally—in a similar spot in a garden in Southwold, Suffolk.

THE TEETH OF THE DUNG FLY.

Four years ago I mounted the head of a fly, which showed a process of teeth at the end of the proboscis; I paid little attention to the subject till Mr. Pillischer, of New Bond Street, showed me a slide, which he informed me had been in his possession for thirty years, and considered unique, of the teeth of a fly. I had, some little time previously, mounted a whole insect, showing the teeth, which Mr. Austen, of the British Museum, at once identified as *Scatophaga stercoraria*, and this being a very common insect, I had no difficulty in obtaining specimens. I find that Mr. W. H. Harris has figured and published an account of the teeth, in the *Proceedings* of the Cardiff Naturalists' Society, so late as July, 1898, and earlier in *Science Gossip*, in 1885.

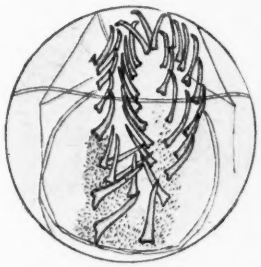


FIG. 1.—Ovipositor of Beetle (*Baptolinus alternans*), × about 40 diameters.

Prof. Packard, in his introduction to "Entomology," also refers to the teeth of the house-fly as being placed between the roots of the false tracheæ, but the tooth figured there has no resemblance to those of the dung fly. These are placed at the base of the labellum of the proboscis, and appear not to be between the roots of the false tracheæ, but to cover them: are of a very tooth-like appearance, chitinous, and stand out well coloured, making a nice object for microscopic examination, with a sixth of an inch power.

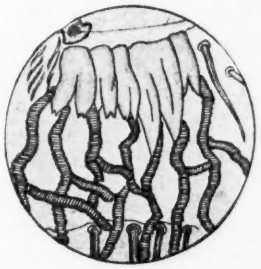


FIG. 2.—Teeth of Fly (*Scatophaga stercoraria*), × about 150 diameters.

Scatophaga is a predaceous fly, and is decidedly raptorial in appearance. It may be seen sitting on leaf, the head well raised on the forelegs, and the body sloped at an angle to its support, watching for smaller flies. A species of *Scatopse* is the smallest, and the house fly (*Musca domestica*) the largest I have seen captured, the blue-bottle (*Lucilia cæsar*) being beyond its powers. It does not hunt, but waits till its prey is within an inch, or an inch and a half, when it is seized with a rapid spring. The wings of its prey are then compressed with the hind legs, which are furnished with many strong spines, or spurs, to assist that operation. The thorax is held with the forelegs, which have a perfect *chevaux-de-frise* of setæ on the end of the tibia, as well as other setæ, arranged in very much the same way as those on the hind leg of the worker honey bee (*Apis melifica*). With the prey thus firmly held, the *Scatophaga* inserts its lancets into the membrane between the head and the thorax, and the tragedy is completed.

FIG. 3.—Proboscis, Lancets, and Maxillary Palpi of Dung Fly (*Scatophaga stercoraria*), × about 25 diameters, showing the position of the teeth.

I had an opportunity on several occasions of verifying an observation of Prof. Packard's, that the true voice of the house fly is a sound produced through the spiracles of the thorax, and not by a hum of the wings. When an unfortunate fly was seized and so firmly held by the *Scatophaga* as to be incapable of movement, I heard a peculiar, characteristic, shrill sound proceeding from it. The teeth obviously play an important part in these struggles, as they must be of great use in tearing and scraping the harder parts, to enable the tracheæ to suck the juices—indeed, I have found the abdomen of a *Scatopse* so treated, and the segments quite broken up. The dung fly also sucks some secretions of plants, as I have many times seen it busy with its proboscis on the viscid disc of the ivy blossom, though its presence there may be not wholly for such an innocent purpose, as these blossoms are much resorted to by other flies.

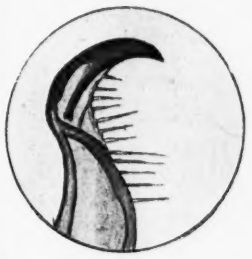


FIG. 4.—Clasper of *S. stercoraria*, × 75 diameters.

It has been said that, contrary to the rule in most insects, the male of *Scatophaga* is larger than the female. I have had several species under observation, *S. stercoraria*, *S. lutaria*, *S. merdaria*, and I cannot endorse this, as I found a great variability in size, some males, apparently of the same species, being a third larger than others, and the same with the females, and I have watched a small male mate with a large female, and *vice versâ*. The males are furnished at the end of the abdomen with two powerful clasping hooks, which are fitted with sharp hairs, arranged like a comb on the inner concave edge. This insect is therefore remarkably specialized in many ways for the "struggle for existence."

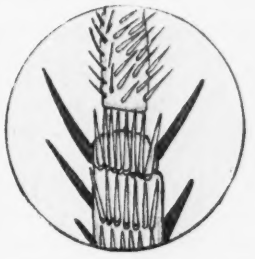


FIG. 5.—Part of Tibia and Tarsi of fore leg of *S. stercoraria*, showing spines used in holding prey, × 150 diameters.

It ought perhaps to be mentioned that the drawings are made from microscope slides, the objects being mounted under pressure, and consequently somewhat altered in shape.

ELECTRICITY AS AN EXACT SCIENCE.

By HOWARD B. LITTLE.

I.—TRADITION, MYSTICISM, AND THE EARLY PURSUIT OF TRUTH.

TRADITION, even that tradition which clings, limpet-like to the adamantine sheath of a science, is, in one respect at least, like antique furniture. If, in the existing generation, the supply be not equal to the demand, then some enterprising child of the period will undertake its manufacture. This is to be regretted, because the poetry of a

science rests (apart from the many instances of self-sacrifice among its devotees) entirely upon its traditions. This alone were good and sufficient reason for cherishing them; but we have another, and a better—we can learn from them.

We have been told by the lay press, told till we are weary, that "Electricity is still in its infancy." Yet we have traditions, which come to us in whispers from a realm of thought that existed six hundred years before the commencement of the Christian era, when Thales of Miletus lived. And we have heard other whispers of "The Secrets of the Gods." But these early traditions, both by accident and design, savour of mysticism. Indeed, the two are inextricably bound up. And we would not have it otherwise.

Let the sceptic cry "*Cum grano salis.*" He may so far forget himself as to ask us to come "up to date." And, as a preliminary step towards his level, we mention incidentally that Theophrastus lived in the year 321 B.C. We may also point out that both Aristotle and Pliny made some shrewd observations concerning the "torpedo" and "the electric eel," while the latter gives a good account of some of the properties of tourmaline.

So much for the infant which we know existed six hundred years B.C., and made its tiny cry heard in the year 70 A.D. A long, long minority, not ended even yet. But in the interval the child still cried. The wailing was long in reaching the ears of our countrymen, though it made itself plainly heard throughout the European continent. At length, however, it found a home here under the guardianship of Dr. Gilbert, of Colchester, about the year 1590. And now the little one began to accomplish articulate speech. We hear of such phrases as "attractive bodies"—remarkable from a child destined to remain an infant for nearly three centuries more, if not for a much longer period, but growing still.

This little one, at certain epochs of whose career we are compelled to glance, this little one, born, perhaps, in a piece of amber, grew phenomenally, yet appeared to be retaining a perpetual youth, outliving guardian after guardian. For when Dr. Gilbert's time came to say farewell (one can believe that it was a sad farewell), Robert Boyle and Otto von Guericke undertook the guardianship simultaneously, yet independently. Robert Boyle brings us up to within thirty years of the commencement of the eighteenth century. But we must revert now to a period when the child passed through a great danger, and was even like to die.

Somewhere about the year 1545 the Elector Frederick of Saxony dreamed a dream, in which he saw Martin Luther writing on the door of the Royal Chapel, at Wittenberg. As he wrote the pen grew—grew so fast and so far that it reached to Rome, and even struck the Pope's tiara. Concerted effort to break the pen was unavailing, for, as it was struck (according to one report), others grew from it. The story of this dream was circulated widely, and one is bound to own that its political aspect almost stamps it as a fabrication. Yet the dream, if dream it were, brought about one good result. It set people thinking, and turned their thoughts towards the ultimate possibility of communicating rapidly at a distance. But the first result was even more strange than the immediate cause. Baptista Porta, in his book "The Wonders of the Magnet" (circa. 1559), wrote:—"I do not fear but that with a far absent friend I can always communicate, by means of two compass needles, circumscribed with an alphabet." Another writer thus stated his conviction:—"Forasmuch as this is so wonderful a secret, I have hitherto hesitated about divulging it, and did so disguise my meaning in the first issue of my book as only to be understood by learned physicians and chemists. But now the time is come when I will communicate it for the benefit of lovers of science generally." One cannot but admire the apt use of that "generally." The writer, evidently himself a lover of scientific truth, goes on to describe the "sympathetic needles." It is curious to note that many writers in the sixteenth and seventeenth centuries speak of these needles as though their use was well-established, while others laugh at the growth of the "conceit." One could so easily draw modern parallels.

It must be remembered that all this was taking place at a time when priests were in the habit of standing in circles around three-legged stools, while one of their number (presumably he who had the greatest command of language) anathematised the stool, till a ring, previously placed upon it, began to roll around it, stopping to indicate certain letters of the circumscribed alphabet, and so interpreting messages from a world otherwise unknown.

Sir Thomas Browne (in his *Pseudodoxia Epidemica*, published in 1646), amongst others, put the needles to experimental test, and stated that he had found the idea to be absurd. Following shortly on this there was another incident. A certain wealthy man was approached by an impecunious individual who wished to sell the secret, and who explained that if the one were in Persia and the other in England it would still be possible to communicate. The man of wealth, telling the other that he would be most happy to test the matter, and give it due consideration, remarked, "But it is not at the moment convenient to me to set out for Persia; none the less, if you will make the journey with one of the instruments, I will gladly remain here with the other, and await the result."

And alchemists were rife in the land, and phlogiston had a recognized existence; so electricity, and every other exact science, was well nigh done to death.

The late Prof. Tyndall, writing of this time, tells us: "Seekers after natural truth had forsaken the direct appeal to Nature, by observation and experiment, and had given themselves up to the re-manipulation of the notions of their predecessors. It was a time when thought had become abject, and the acceptance of mere authority led, as it always must do in science, to intellectual death. Natural events, instead of being traced to physical, were referred to moral causes, while an exercise of the fantasy, almost as degrading as the spiritualism of the present day, took the place of scientific research."

This is in truth a just appreciation of the state of affairs existing then. But we have no great right to laugh. As heirs to the ages, it remains for us to show that we have done our best. We have heard in our own time of the production of electrical sugar, as also of certain belts! The blame for these things should be divided about equally, between those who do know and those who do not. It is a painfully mean spirit which prompts a man who has made a life study of a particular subject to laugh at the ignorance of that subject shown by another, who has spent his time in the pursuit of some other knowledge, though the latter is to blame when he turns a deaf ear to the warning given, ever so quietly, by the former. And very many writers of "Science Notes" in the lay press should not be quite so prolific.

But returning to the subject of tradition. A careful note of that tradition, and mysticism, which has hung about electrical phenomena leads us to assert the inevitable proposition that electrical science owes its present position to the facts, and distortions of facts, propounded by the ancients.

Democritus said "We know nothing really, for the truth

lies deep down." And the same assertion has been made again and again, in varying terms. Yet we often meet the truth quite unexpectedly, and it is not always pleasant. Other truths, again, had been staring the world (including the seekers after them) in the face for years before they were recognized. Ancient India has a tradition to the effect that it was children who first found that the friction of certain substances rendered them capable of attracting fragments of straw, feathers, etc. We are bound to admit that here was a truth over which men might have stumbled.

It appears, then, that in the early stages of scientific discovery, first one or two facts are accidentally noted, these may, in logical sequence, give rise to the discovery or recognition of others, till ultimately a spirit of enquiry has its birth, though perhaps only in the minds of one or two. It is given to these pioneers to leaven the lump, and though there may be times when neglect and error will almost put out the first glimmerings, yet that neglect and those errors will work towards the ultimate discovery of truth. Consider the evolution of the telegraph. We have there a series of events which may well serve as a type of the struggles of a science. First, the alleged dream, which may have had its existence only from political, religious, or irreligious necessity. The immediate result was the notion of communication at a distance, and it was distributed broadcast. The next result was by no means so happy, for either a great number of people accepted with blind credulity a statement which was absurd, or deliberate untruths were told for purposes of self aggrandisement.

Yet, throughout that period, there were one or two honest men whose calm spirit of research saved them from being carried down with the stream. And these workers in time actually stemmed the torrent.

In the year 1753 the *Scots' Magazine* published an article (signed "C. M.") in which a perfectly practical scheme was set forth. Twenty-six wires and twenty-six pith balls suspended close to their ends, *and a circumscribed alphabet*. Can nothing good come from evil?

It is interesting to note, that for some two thousand years before Dr. Gilbert's time (1540—1603), we find only a disjointed series of electrical facts mentioned, usually, too, as matters of common knowledge. There was apparently no real effort made to arrive at well-founded conclusions from those facts. Boyle and Von Guericke brought us up to the close of the seventeenth century almost. The latter appears to have been the first to arrange a mechanical device for the generation of electricity, for he worked with a sulphur ball, which had actually been cast in glass that he deliberately broke! Mounting this ball on a spindle he rotated it, and, holding the hand against it, excited it. It was reserved for Newton to realize that the original glass globe would have answered the purpose better.

But the names of active workers come now so thick and so fast that it is only possible to make a selection.

Stephen Gray claims our attention. His work was vigorous and of real use. He published, in 1720, a report upon the results obtained by the friction of various substances. In 1729 he enunciated the first ideas of conductivity, and succeeded in conveying electrical energy a distance of eight hundred and eighty-six feet through a packthread suspended on silk supports. How many modern electricians, working with Gray's appliances, would care to undertake this? It was Gray, too, who showed that fluids would conduct. Finally, he wrote, "I hope that there may be found out a way to collect a greater quantity of electric fire, and consequently to increase the force of that power, which, by several of these experiments, *si licet magnis componere parva*, seems to be of the same nature with thunder and lightning."

Next, the prime conductor was added to the electrical machine. It is not without interest to note that this was at first "supported by a man, standing upon cakes of resin"!

Then Prof. Winkler added the cushion, about 1744. Gordon, of Erfurt, having himself improved the apparatus, arranged some really beautiful experiments, as, for example, the ignition of fluids by a jet of electrified water.

It was with the birth of the Leyden jar, 1745, that Gray's hope was to be realized. One hardly knows to whom it should be attributed.

Sir William Watson achieved one of the first practical results, for, by mixing camphor with gunpowder, he succeeded in discharging a musket electrically. Then, having coated the Leyden jar on both sides, he worked, under the auspices of the Royal Society, upon the velocity of electrical discharge. The conclusion then arrived at was perfectly natural, the report stating that the discharge through twelve thousand two hundred and seventy-six feet of wire was instantaneous.

Benjamin Franklin next claims our attention. First he told the world that the electricity obtained by friction was not created but collected. This seems to have done more to raise electricity to the level of an exact science than anything we have yet considered. So far we have found that experiment predominated over deduction to a very great extent; but now a change came. Franklin, appreciating the work of Gray, constructed his kite, and brought a part of the lightning to earth, so showing that "it was of the same nature with the electric fire."

The first electrician who became a martyr to the pursuit of truth, Prof. Reichman, of St. Petersburg, was working with what would now be called a lightning conductor, on August 6th, 1753, and died from the very success of his own experiment.

The atmosphere of thought, throughout the entire continent, was charged with electricity now. Beccaria, the Italian, did work upon atmospheric electricity which should be of great interest to meteorologists now.

But the march of time carries us on. Galvani was busy, and Volta's pile was in use with the dawn of the present century. Then Sir Humphry Davy decomposed "the solid earth."

Here was the heterogeneous collection of fact laid ready to the brain and the hand of the first really mathematical electrician. Coulomb came. The torsion balance had an existence. He adopted the hypothesis of two fluids, and investigated the *laws* of distribution and density. In short, he treated electrical quantities as being subject to accurate mensuration. Laplace, Levoisier, and Volta did work at about this time which appears to have been neglected. They entered upon investigations relative to the connection between electricity and evaporation.

Poisson placed electrical phenomena under the dominion of analytical reasoning, so that at his hands the study increased its right to be looked upon as an exact science. Oersted and Ampère followed, so that electro-dynamics became almost a separate study. Truly the infant was in no want of men who could and who would fulfil their duty as sponsors.

The story of Michael Faraday's induction coil is a grand lesson to modern workers. Also we have Joule's splendid error, which showed in after years the accuracy of his work and the inaccuracy of the ohm, according to the standards which prevailed then. Wilhelm Webber, Kirchoff, and Helmholtz now seem to head the crowd which comes thronging round us, and they introduce our contemporaries; but we can make no further mention of them here, for it seems we have clearly worked our proposition to a proof,

XUM

and electrical science, like every other science, owes its present position to the facts, and distortions of fact, propounded by the ancients.

NOTES ON COMETS AND METEORS.

By W. F. DENNING, F.R.A.S.

DISCOVERIES OF COMETS.—The year 1898 forms a record as regards the number of cometary discoveries and observations. Altogether ten comets have been seen up to the end of November, and of these three were returns of the periodic comets of Pons-Winnecke, Encke, and Wolf. Perrine has been the most successful observer, having detected Pons-Winnecke's comet as well as three new comets. It is remarkable that two of these bodies were accidentally found during the year by means of photography, viz: one by Coddington, on June 11th, and another, in the Leonid radiant, by Prof. P. E. Chase, on November 14th. It was a curious circumstance that a new comet should be placed in a position within the sickle of Leo on the very date when a meteoric shower was expected, and when scores of cameras were directed to that particular part of the firmament. The wonder is that the comet was not independently detected by a large number of observers. It passed its perihelion on September 19th, but at the opening of January, 1899, will be a little brighter than on the date of its discovery, and situated about 8° northwards of the star δ Leonis. On January 11th the comet will be in R.A. 11h. 8m. and Dec. +30° 32′, while on January 15th its position will be R.A. 11h. 9m. and Dec. + 31° 18′.

BROOKS'S COMET.—Is now invisible near the sun, but will probably be seen by observers in the southern hemisphere in February.

WOLF'S COMET.—Is nearly stationary in Canis Major. On January 5th the comet will be 2½° west of the brilliant star Sirius.

THE LEONID METEORS.—Though a brilliant display was far from being realized, it seems that, at some stations, a tolerably active shower was observed. At Alassio, on the Riviera coast, Mr. Hardcastle found the numbers remarkably constant at about thirty per hour. Prof. Young, at Princeton, U.S.A., observing with Prof. Reed on November 15th, 3h. 15m. to 5 a.m., counted about one hundred. There were about a dozen as bright as stars of the first magnitude, and all of them left streaks. The maximum was at 3.45 a.m. (= G.M.T. 8.45 a.m.), when for twenty minutes meteors appeared at the rate of two or three a minute. The radiant was not well defined, but its centre was nearly in 151° + 22½°. At Rome fine weather favoured the observations. At the observatory there on the night of the 13-14th, during about two and a half hours before midnight, fifty-five meteors were counted, while in a similar period after midnight, one hundred and four were seen. On the night of the 14-15th, during two and a half hours after midnight, one hundred and twenty-six meteors appeared, and of these thirty-six were of the first magnitude and thirty-six of the second magnitude. Twenty-six left trains. The total period of observation during the several nights was 11h. 38m., and the aggregate number of meteors seen four hundred and eighty-six. The work was distributed amongst nine observers, who divided the watches on successive nights, but it is not stated how many of these were looking out at the same time. The recent observations, coming from different quarters, are singularly discordant as to the number of meteors visible. At some places no meteors appear to have been seen, while at others a well defined and somewhat numerous display of Leonids was witnessed.

THE BIELID METEORS.—In England cloudy weather and moonlight effectively veiled all traces of this shower. It is highly probable that it quite failed to return in the strength expected, and that, even had clear skies permitted full observation, the results would have been negative. The period of thirteen years is evidently too short for maximum returns of the shower. It may furnish some meteors on November 23rd, 1899, and ought to give a very brilliant display on about November 17th, 1905.

THE QUADRANTIDS.—Many of these meteors are likely to be visible on the evening of January 1st, and the morning and evening of January 2nd. The best time to look for them will be before moonrise on the early mornings of the dates mentioned.

Microscopy.

JOHN H. COOKE, F.L.S., F.G.S.

No one, probably, has done more towards increasing our knowledge of the nature and disposition of the cell contents of diatoms than Pfitzer. One of the difficulties that that distinguished worker experienced in the study of his subject was the differentiating of the fine colourless plasm in the plasm sac. This was chiefly due to the fact that the refractive index of the plasm differed but slighty from that of water. To overcome this he suggested the application of dilute hydrochloric acid. The result, happily, was the immediate shrinkage of the plasm sac and the disclosure of its structure. A one per cent. solution of osmic acid has been found to be even more effective, as it not only has an effect on the plasm sac similar to that of hydrochloric acid, but, by changing the oil globules, that are invariably present in the cells, to a black colour, it enables the worker to readily study the relations of the various matters that make up the cell-contents.

It is well known that, other things being equal, the higher the refractive index of a mounting medium the more effective is the medium for microscopical manipulations. The mounting fluids most commonly used are—oil of turpentine, refractive index, 1·475; castor oil, 1·49; Canada balsam, 1·549; oil of cloves, 1·535; balsam of tolu, 1·628; and oil of cassia, 1·641. It may be of interest to microscopists to have their attention drawn to a little known, but effective mixture, having a refractive index as high as 2·40, which was discovered by Prof. Hamilton Smith, of Rochester. The mode of preparation is as follows:—In two fluid drams of glycerine jelly, made in the usual way, dissolve, in the cold, ten drams of chemically pure stannous chloride. When solution is complete boil for a few minutes, and filter while hot. When mounting place a drop on the slide and heat in the usual way. The difference in the appearance of diatoms mounted in this medium and in other fluids must be seen to be appreciated.

In the *Journal of Applied Microscopy*, Mr. G. H. French describes the method that he adopts for imbedding and staining lichens. He recommends the immersion of the lichens in ninety-five per cent. alcohol for twenty-four hours, after which they should be placed in thin and thick collodion, alternately for another twenty-four hours. After imbedding in thick collodion, and hardening in seventy per cent. alcohol, the sections are cut, and stained with borax-carmine. The fungus part of the lichen will, after this treatment, acquire a pale pink hue, while the algal cells acquire a greenish-red shade. By this method the host cells may be readily distinguished from the fungus.

At a recent meeting of the Quekett Club, Mr. Goodwin gave the results of his experiments in illuminating microscopic objects without the aid of a bull's-eye condenser. Under ordinary conditions the lamp has to be placed at a distance of about eight inches from the back of the condenser in order to secure the best effects. By placing a plano-convex lens, of five-inch focus, in the screen-holder of the condenser, he has been enabled to bring the lamp to within three inches of the back of the combination, thus obtaining better illumination and definition, a matter of considerable importance when high powers are used. It is a simple and effective contrivance, and is worthy of the attention of those who desire to make the best use of their appliances.

There is no better cement for general "mounting" purposes than old gold size. The older the better for the purposes of the microscopist. Gold size is, in reality, nothing but good linseed oil rendered very drying by the usual methods. It has many advantages over damar, asphalt, and the many other cements on the market, as it may be laid on readily and quickly in successive coats, and, though it mixes with turpentine, it is unaffected by it when once hard and dry. The cement should be prepared in small quantities, and in the following manner:—Take a small quantity of old gold size, thin it with turpentine, and work in enough lamp-black or aniline dye to colour it. This will dry tough, and with a beautiful gloss. If a ring of shellac varnish be made round the edge of the cell, and, when dry, this cement be applied in a succession of coats as a "finish," the microscopist will have a mount which, with fair usage, will last for years.

THE FACE OF THE SKY FOR JANUARY.

By A. FOWLER, F.R.A.S.

THE SUN.—Although solar activity is probably on the wane, observations should by no means be discontinued. Even in the absence of spots, faculæ may frequently be observed.

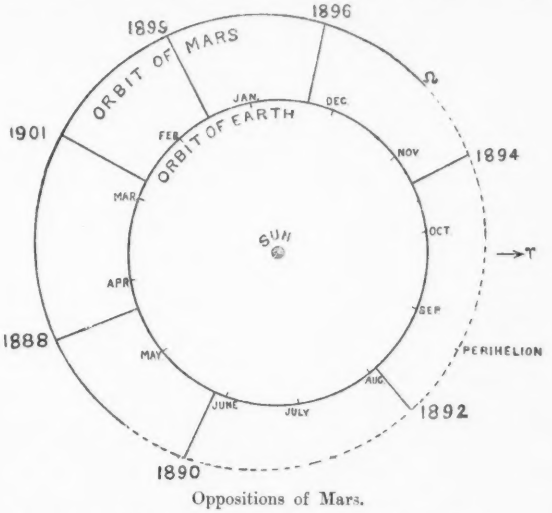
There will be a partial eclipse of the Sun (greatest magnitude = 0·7) on the **11th**, but as it will only be visible in the region of the North Pacific, further particulars are not considered necessary.

THE MOON.—The Moon will enter her last quarter on the **5th**, at 3.22 A.M.; will be new on the **11th** at 10.50 P.M.; enter her first quarter on the **18th** at 4.36 P.M.; and will be full on the **26th**, at 7.34 P.M. Of the various occultations during the month, the most conveniently observable is that of μ Arietis, mag. 5·8, which will occur on the **19th**; the disappearance will take place at 8.5 P.M., 45° from the north point (22° from the vertex), and the reappearance at 9.14 P.M., 282° from the north point (248° from the vertex), the position angles being reckoned through east.

THE PLANETS.—Passing from his recent inferior conjunction, Mercury will arrive at his greatest western elongation of 23° 35′ on the **12th**. He will accordingly be a morning star throughout the month, but his great southerly declination, which amounts to 22° on the **12th**, makes the planet too low for easy observation in our latitudes.

Venus is also a morning star, and will attain her greatest brilliancy on the **6th**; she will then be about 16° south of the equator, but will be a conspicuous object in the morning sky, rising about three hours before the Sun. About one-third of the disc will be illuminated.

Mars will be in opposition at midnight on the **18th**, so that the present month will furnish the most favourable opportunity of observing the planet that we shall have for several years. Unfortunately, he is in the part of his orbit furthest removed from the Sun, so that his disc will not be very large. His distance at the present opposition, as compared with that at other oppositions, is illustrated in the accompanying diagram. At the time of opposition, his horizontal parallax will be 13·6″, representing a



Oppositions of Mars.

distance of about 143 millions of miles. The apparent diameter of the planet will then be 14·4″, but for observers in northern latitudes the northerly declination of the planet will partly compensate for the smallness of the disc. The north pole of the planet is tilted towards the earth. During the month he describes a westward or retrograde path through Cancer towards Gemini.

Jupiter is a morning star, and will be at quadrature on the **29th**. During the month he describes a short direct path in the preceding part of Libra, rising about 3 A.M. at the beginning, and before 1 A.M. towards the end of the month.

Saturn is also a morning star. He describes a short eastward part in the southern part of Ophiuchus, and does not rise very much before the Sun until the end of the month, when he rises about three hours before the Sun.

Uranus is a morning star, rising about four hours before the Sun towards the end of the month. He traverses a short direct path near ψ Ophiuchi.

Neptune describes an eastward path of 80′, starting from a point about 1° north-east of ζ Tauri. He is visible throughout the night.

THE STARS.—At the beginning of the month Canis Major will be due south about midnight, Orion about 11 P.M., Taurus about 10 P.M., and Aries about 8 P.M. These constellations will be in the same positions roughly half-an-hour earlier at the end of each succeeding week.

Conveniently observable minima of Algol will occur on the **2nd** at 7.14 P.M.; on the **22nd** at 8.57 P.M.; and on the **25th** at 5.46 P.M.

Chess Column.

By C. D. LOCOCK, B.A.

Communications for this column should be addressed to C. D. LOCOCK, Netherfield, Camberley, and posted on or before the 10th of each month.

Solutions of December Problems.

No. 1.

(By F. W. Andrew.)

1. B to Kt8, and mates next move.

No. 2.

(By N. E. Meares.)

Key-move—1. P × Pch.

If 1. . . . K to Q4, 2. Castles (QR)ch.
1. . . . K to Q2, 2. R to Qsq ch.
1. . . . K × P, 2. Castles (KR)ch.

CORRECT SOLUTIONS of both problems received from D. R. Fotheringham, W. de P. Crousaz, H. Le Jeune, H. E. Gardner.

Of No. 1 only, from Alpha, W. Clugston, J. M'Robert, G. G. Beazley, J. G. Sheakston, G. F. T., G. C. Teddington, W. H. Stead.

H. E. Gardner.—We are glad to see that the sui-mate has found a solver and an appreciator.

G. F. T.—See answer to Alpha below.

H. S. Brandreth.—If 1. B to Q6, Kt to B3, and the Queen would like to mate at Q7. See also reply to Alpha.

Alpha, and others.—After 1. P × Pch, K to Q2, 2. Castles ch ?, K to QB2, White's QB is pinned. This, of course, is part of the composer's idea. In the three variations, White castles on both sides, and also moves his R to Q square. The composer informs us that he tried in vain to add a fourth variation to consist of "half-castling" on the King's side.

J. G. Sheakston.—When the King goes to Q4, White must castle. For after 2. R to Qsq ch, K × Kt, the Queen

is pinned and cannot give the pretty mate at QKtsq (Q × P would not be mate in any case).

C. J. Shears.—In No. 1, Kt to K4 is met by P to Kt5ch. In No. 2 the White Queen, being pinned, cannot mate at Q6.

W. Clugston.—The delay was due to the omission to print Mr. Andrew's problem a month earlier.

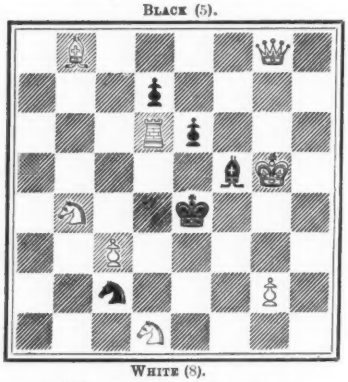
J. Nield.—Many thanks for the problems.

PROBLEMS.

No. 1.

By W. Clugston.

BLACK (5).



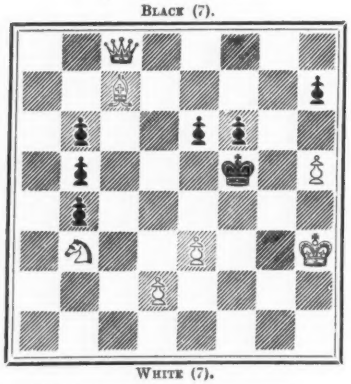
WHITE (8).

White mates in two moves.

No. 2.

By C. D. Locock.

BLACK (7).



WHITE (7).

White mates in three moves.

CHESS INTELLIGENCE.

We regret to announce the death of the Rev. A. B. Skipworth, for many years Rector of Tetford, Horncastle. We may safely assert that this address is more familiar to the chess world than that of any chess-player who ever lived. Mr. Skipworth was the founder, and, for some thirty years, the honorary secretary, and always the life and soul of the Counties Chess Association, which for more than twenty years held its annual largely attended tournaments in the provinces. As an amateur player he was quite in the front rank, but owing to ill-health was unequal to the strain of a prolonged tournament. He was a competitor in two international tournaments, London, 1883, and Bradford, 1888, but in both cases was obliged to retire before the conclusion of the contest. In the less arduous conflicts of the Counties Chess meetings, he was far more successful, in spite of the severe handicap imposed by the task of managing the work of the meeting, which almost entirely devolved on him alone. In this respect, indeed, as in many others, Mr. Skipworth's place will not easily be filled.

Messrs. Janowski and Showalter are engaged in a match in the United States. The French champion won the first two games, but Mr. Showalter soon got into form, the score at present being—Janowski, 3; Showalter, 2; drawn, 2. The match goes to the winner of the first seven games. On tournament form M. Janowski is the stronger player of the two, but Mr. Showalter is at his best in a match, and, unfortunately, even better than his best in the Anglo-American Cable Match, in which he has won his game in three consecutive years.

The British Chess Club defeated the St. George's Chess Club on December 10th, after a close contest, by $5\frac{1}{2}$ games to $4\frac{1}{2}$. The game between Messrs. Burn and Jackson, the respective leaders, was drawn; the same result occurred in their game last year, on which occasion the St. George's Club did not succeed in winning a game. On the present occasion the "tail" of the British team nearly succeeded in losing the match.

On November 19th Kent and Hampshire met for the first time in the history of the Southern Counties Chess Union. The result was a drawn match, each side winning eight games. There is little doubt that Surrey will, as usual, be the ultimate winners of the championship.

KNOWLEDGE, PUBLISHED MONTHLY.

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The Beet-Sugar Industry in England. By John Mills.
The Karkinokosm, or World of Crustacea.—VI. By the Rev. Thomas R. R. Stebbing, M.A., F.R.S., F.L.S. (*Illustrated.*)
Self-Irrigation in Plants.—III. By the Rev. Alex. S. Wilson, M.A., B.SC. (*Illustrated.*)
Progress in Radiography. By James Quick.
Handicraft in the Laboratory.
The New Planet DQ. By A. C. D. Crommelin. (*Illustrated.*)
The November Meteors. (*Illustrated.*)
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Chess Column. By C. D. Locock, B.A.

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PLATE.—The Colours of Cowries.

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